INSTRUCTION BOOK

FOR

POWER UNIT PE-215-A

MANUFACTURED BY

INTERNATIONAL DIESEL ELECTRIC CO., INC.

PRO PATRIA VIGILANS

PUBLISHED BY AUTHORITY

OF

THE CHIEF SIGNAL OFFICER

ORDER NO. 1628-PHILA-43 DATE 1943

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MATERIAL FURNISHED
ON
SIGNAL CORPS ORDER No. 1628-PHILA-43
POWER UNIT PE-215-A

ITEM	IDENTIFICATION	MANUFACTURER
Engine	Model UD-18	International Harvester Co.
Lubricating Oil Filters	Type VW-864	Motor Improvement Co.
Fuel Oil Filter	Type VW-865-A	Motor Improvement Co.
Air Cleaner	Type 51232D	Donaldson
Silencer	Model STC-3	Burgess Battery Co.
Batteries	Type TSR4-190	Autolite Co.
Battery Charging Generator	Type 1101737	Delco-Remy
Starting Motor	Type 1109106	Delco-Remy
Magneto	Model F-6	International Harvester Co.
Safety Device	Model No. 530	Fulton-Sylphon Co.
Fuel Injection Pump	Model A	American Bosch Co.
Metal Exhaust Hose	Type RW89	Chicago Metal Hose Co.
Fan Guard, Right Side	Model 631-18A	International Diesel Electric Co.
Fan Guard, Left Side	Model 631-19A	International Diesel Electric Co.
Tool Box	Model 631-10-23	International Diesel Electric Co.
Coupling	Type 2B0—3⅛ in.	Ajax Coupling Co.
Alternator	Type AT1, Frame 953E, Form HA	General Electric Co.
Exciter	Type BC, Frame 78	General Electric Co.
Steel Base	Type 631-2X	International Diesel Electric Co.
Control Cabinet Support	Type 631A-23X	International Diesel Electric Co.

MAINTENANCE SCHEDULES

DAILY OR AFTER 10 HRS. OPERATION

1—Check lubricating oil level with bayonet gage and add oil, as necessary.

2—Check cooling water level.

3—Read and record all instruments.

4—Test the alarm system.

5—Drain water from auxiliary fuel oil tank.

6—Clean air filter and change oil.

7—Examine alternator, exciter and battery charging generator for sparking at the brushes.

8—Lubricate water pump shaft at capped fitting with hand pressure gun. About 2 strokes will suffice.

WEEKLY OR AFTER 60 HRS. OPERATION

1—Check storage battery specific gravity.

2—Check level of electrolyte in battery cells.

3—Tighten bolts holding unit to base and base to foundation.

4—Lubricate fan hub bearing fitting with grease gun. 2 strokes.

5—Oil magneto impulse coupling. Use a light oil such as sewing machine oil.

6—Check for fuel oil, lubricating oil, gas and water leaks.

7—Clean unit thoroughly.

8—Clean switchboard front.

9—Clean switchboard back (with compressed air if available).

10—Clean strainer on fuel supply pump.

AFTER 100 HRS. OF OPERATION

1—Clean radiator air passages.

2—Clean fan blades.

3—Check all electrical connections.

4—Change oil in crankcase.

5—Change oil in injection pump.

6—Check bolts on flexible coupling.

7—Clean battery terminals.

8—Check belts for proper tension.

9—Oil starting motor.

10—Clean oil breather.

11—Replace lubricating filter element.

AFTER 250 HRS. OF OPERATION

1—Clean spark plugs and check spark plug gaps.

2—Check distributor gap.

3—Check bendix drive by removing starting motor.

4—Clean circuit breaker contacts.

5—Flush out cooling system.

6—Check water pump packing; repack, if necessary.

7—Check commutators and slip rings.

PERIODICALLY

1—Oil and grease the magneto.

2—Clean main storage fuel oil tank.

3—Clean gasoline tank.

4—Check all valves for compression leaks.

5—Clean silencer.

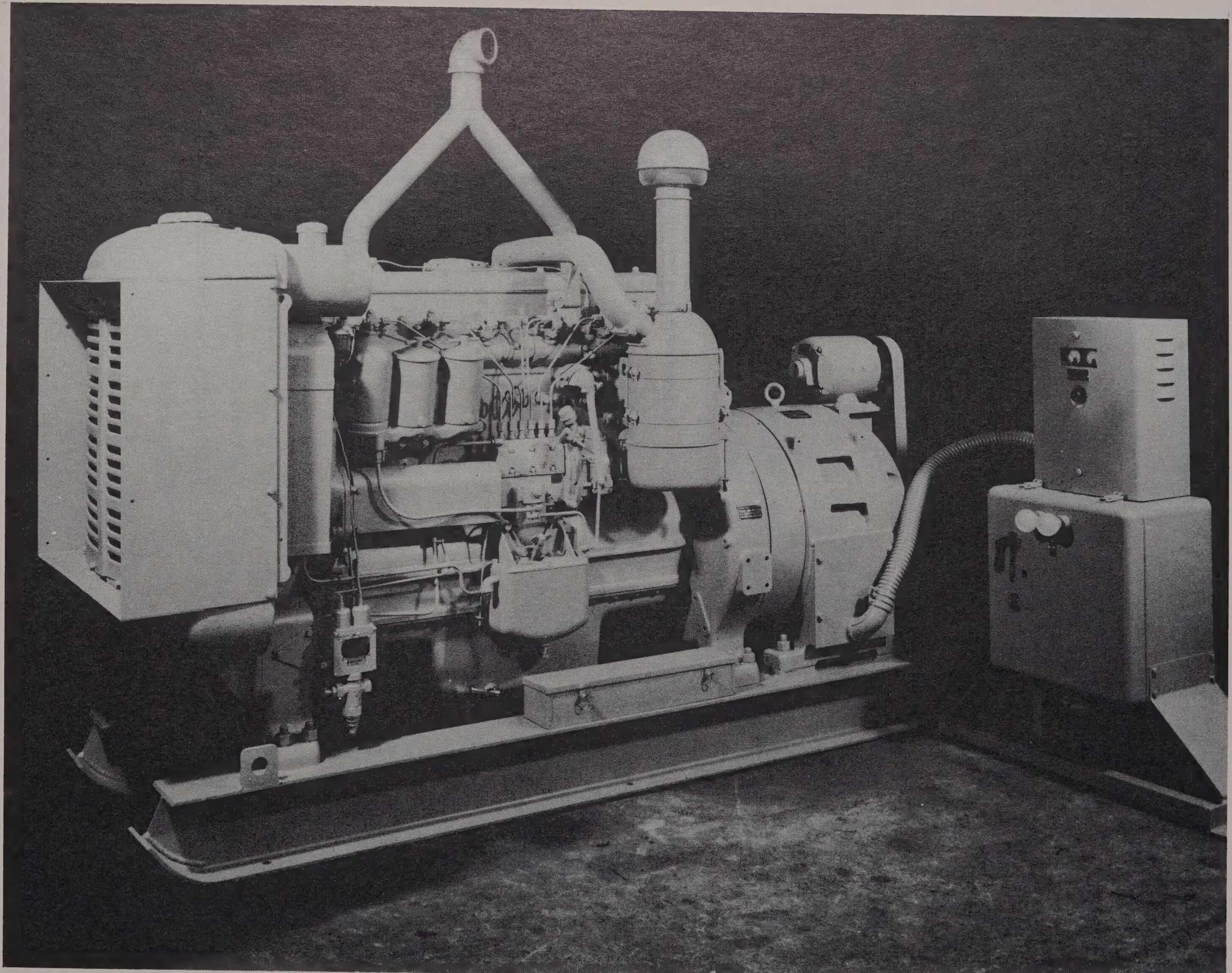

FIG. 1 — POWER UNIT PE-215-A

A. DESCRIPTION OF EQUIPMENT

1. GENERAL DESCRIPTION

a. *Power Unit*—The power unit consists of a full Diesel engine, driving an alternating current generator by direct coupling, and switchgear. The unit is designed to supply power for the fixed radio communications of the United States Army. The principal application is to supply power to operate a CW radio transmitter.

b. *Engine* — The engine is a 6 cylinder, 4 stroke cycle, water cooled, vertical, stationary type. The cylinder bore is 4¾ inches and the stroke is 6½ inches. It has a piston displacement of 691.1 cu. in. The engine develops 76 horsepower under continuous operation, with accessories, at the governed speed of 1200 RPM. It is manufactured by the International Harvester Company and designated by that company as Model UD-18.

c. *Alternator*—The alternator is 6 pole, 60 cycles, 3 phase, 4 wire, producing 240 volts at the engine driven speed of 1200 RPM. It is rated at 50 KW, 62.5 KVA, 80% power factor, 150 ampere output and is designed for continuous operation. The maximum temperature rise on the stator is 40°C. measured by thermometer and 50°C. rise on the rotor measured by resistance. It is insulated with Class A insulation. The frame is drip proof, semi-enclosed, self-ventilated. The alternator is designated, by the General Electric Company as Type ATI, Frame 953E, form HA.

d. *Exciter*—The necessary exciter is top mounted, belt-driven, from the alternator rotor at 2000 RPM. It is shunt wound, 1.5 KW, 64 volts. The frame is drip proof construction. The exciter is General Electric Company Type BC, Frame 78. It has Class A insulation and has a maximum temperature rise of 40°C.

2. ENGINE ACCESSORIES

a. *Cooling System*—The cooling system consists of a flat tube, fin type radiator; a fan to cool the water; a positive centrifugal water pump; a thermostat and a water temperature dial type thermometer. The fan and the pump are belt-driven. The tension of the belts is adjustable.

b. *Fuel System*—The Diesel fuel system consists of the following parts: Supply pump strainer; supply pump—approximate capacity of 25 gallons per hour; intermediate or "day" tank; an oil filter; Bosch transfer pump; Bosch injection pump; injection nozzles and the necessary interconnecting piping. An oil storage tank forms part of the fuel oil system, but is not supplied with the unit.

c. *Cranking System*—In addition with being equipped with a hand crank for starting, there is an electric starting system comprising a starting motor, which operates on a gear on the rim of the flywheel; a twelve volt storage battery (two 6-volt batteries connected in series), to supply power for the starting motor, and a starter switch located on the engine instrument panel over the flywheel housing. A battery charging generator is included in the system. This is located on the manifold side of the engine and above the magneto. A voltage regulator control, mounted on this generator frame, prevents the generator from overcharging the batteries. This generator is protected by a metal shield.

d. *Gasoline Starting System*—The engine is equipped with a gasoline and ignition system similar to that of the typical automobile, that is, gasoline tank, carburetor, magneto, distributor and spark plugs. The magneto supplies the current to spark the plugs, replacing the usual storage battery and coil. This system is used only for starting, and for this purpose the engine is temporarily converted to a low compression gasoline engine by moving a lever, on the left-hand side of the engine, to a position which accomplishes this.

e. *Intake Manifold*—

(1) TYPE—The intake manifold used on the engine is of the dual type. Only one of the passages in this manifold is used during the starting operation; the other is used for Diesel operation.

(2) AIR VALVE—An air valve of the mushroom type is installed in the manifold, which closes off the Diesel passage of the manifold when starting the engine on gasoline. This valve also closes off the gasoline passage when the engine is operating on fuel oil.

(3) MAGNETO CUTOUT SWITCH—A magneto cutout switch is located in a compartment in the front end of the manifold and is attached to the air valve shaft. This switch grounds the magneto after the engine is switched from gasoline to Diesel operation.

f. *Carburetor*—A dual manifold carburetor is provided for gasoline starting. It is equipped with a manually operated priming device which injects gasoline into the intake manifold. This is used to facilitate starting a cold motor. The carburetor is completely out of service during Diesel operation of the engine.

g. *Compression Release Lever*—This lever, located on the left-hand side of the engine, is used to change

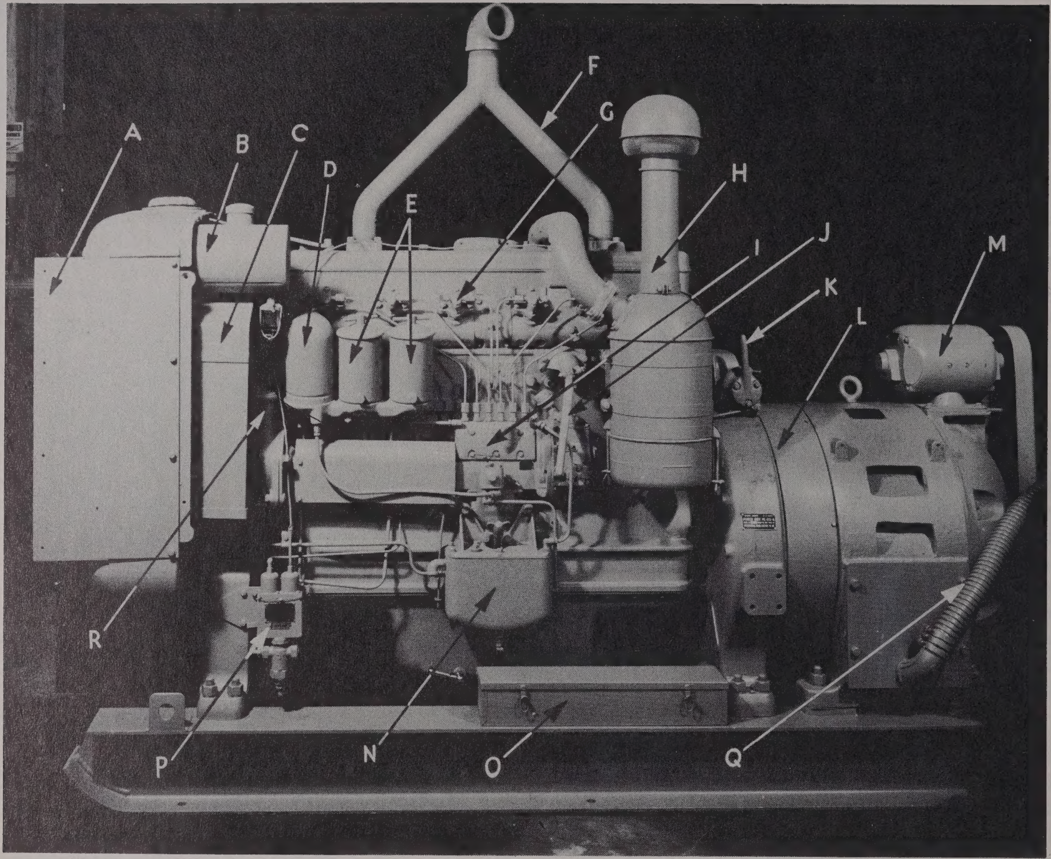

FIG. 2 — POWER UNIT PE-215-A (LEFT SIDE)

A—Frame for Canvas Duct
B—Gasoline Tank
C—Fan Guard
D—Fuel Oil Filter
E—Lubricating Oil Filters
F—Exhaust Connection

G—Spray Nozzles
H—Air Cleaner
I—Injection Pump
J—Compression Release Lever
K—Throttle Lever
L—Alternator

M—Exciter
N—Day Tank
O—Tool Box
P—Safety Shut Down Device
Q—Cable Conduit to Control Cabinet
R—Oil Filler

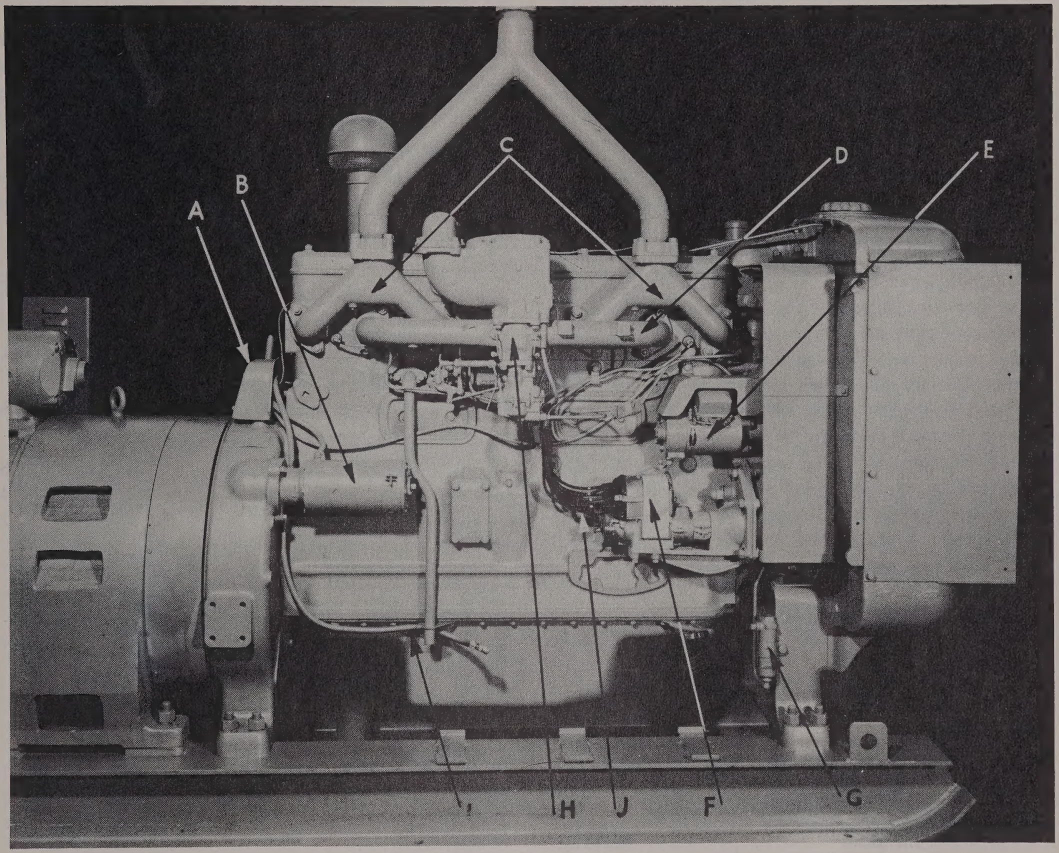

FIG. 3 — POWER UNIT PE-215-A (RIGHT SIDE)

A—Engine Instrument Panel	**F—Magneto**
B—Starting Motor	**G—Supply Pump Fuel Strainer**
C—Exhaust Manifolds	**H—Carburetor**
D—Intake Manifold	**I—Battery Cable**
E—Battery Charging Generator	**J—Spark Plug Cables**

the engine from gasoline to oil operation or oil to gasoline.

h. *Air Intake*—Clean air for combustion is assured by an oil bath type air cleaner. This is located to the left of the rear cylinder.

i. *Exhaust System*—Exhaust gases pass out through two cast iron manifolds, each taking care of the gases from three cylinders. The outlets of these manifolds lead into an inverted "Y" section. A flexible exhaust hose is connected to the single outlet of this section and the silencer is attached to the other end of this hose.

j. *Lubrication System*—Lubrication is full force feed to crankshaft and connecting rod bearings, piston pins, bushings, valve mechanism and timing gears. The lubrication system consists of a gear oil pump; floating oil screen; two oil filters; oil pressure regulator; pressure gage; oil pan thermometer and the necessary piping and fittings. The oil pump is located in the crankcase as is also the floating, screened, oil intake. The oil filters are located on the left-hand side of the engine to the rear of the fuel oil filter. The oil pressure regulator is a plunger type regulating valve located in the oil pump body. The oil pressure gage is on the instrument panel over the flywheel housing. A bayonet gage is provided, on the left-hand side of the engine, which indicates the level of the oil in the crankcase.

3. ENGINE—SPECIFICATIONS

a. *General*—

Bore and Stroke	4.75x6.5"
Cylinders, No.	6
Cylinders, Type	Wet Liner
Displacement, Cu. In. per Rev.	691 Cu. In.
Governed R.P.M.	1200
Piston Speed, Ft. per Min. at 1200 R.P.M.	1300
Compression Pressure	465 Lbs.
Compression Ratio	13.67 to 1
Fuel	Diesel
Horsepower	76

b. *Ignition System*—

Type	Starting Only
Magneto Grounding Switch	Automatic
Magneto, Mfg. and Model	I. H. Co. F-6
Rotation	Clockwise
Breaker Point Gap, In.	.020"
Spark Advance	2½°
Impulse Coupling Advance	13° after T.D.C.
Magneto Gear	Helical
Drive Gear	Camshaft
Spark Plug, Size	S.A.E. ⅞"-18
Spark Plug Gap, In.	.035 to .040"
Firing Order	1-5-3-6-2-4

c. *Carburetor*—

Type	Starting Only
Model, I. H. Co. Mfg.	I. H. Co. C-12
Fuel Supply	Gravity
Fuel Level Below Top of Bowl	¼"
External Adjustments	None

d. *Lubrication*—

Capacity U. S. Quarts	22
Pressure System	Yes
Oil Filter	N-17 Purolator (2)
Oil Pressure Valve	In Oil Pump Body

e. *Oil Pressure Valve Regulating Spring*—

Free Length	3-3/32"
Test (Minimum Pressure)	47.6 lbs. at 2-3/32"

f. *Piston Assembly*—

Piston Material	A-132 Aluminum Alloy
Clearance at Bottom of Skirt	.0085-.0095"
"Go" Gauge (½" wide)	.006"
Light Pull	2-4 lbs.
"No Go" Gauge (½" wide)	.008"
Tight Pull	11 to 14 lbs.

g. *Piston Rings*—

Total Required	6
Compression	4
Oil Control	2
Width Compression	.1230-.1240"
Width Oil Control	.2485-.2490"
Gap	.010-.020"
Clearance in Groove, 1st Compression	.004-.005"
Clearance in Groove, 2nd Compression	.003-.004"
Clearance in Groove, 3rd & 4th Compression,	.0025-.0035"
Clearance in Groove, Oil Control	.0025-.0035"

h. *Piston Pin*—

Type	Full Floating
Retainers	Snap Rings
Length	4.105"
Diameter	1.6250-1.6253"
Clearance in Rod Bushing	.0003-.0005"
Clearance in Piston Bore	.0001-.0003"

i. *Connecting Rod*—

Length (Center to Center)	13¼"
Crank Pin Diameter	3.2480-3.2485"
Bearing Material,	Babbit over Copper-lead Steel Back
Bearings, Length (Total)	2-1/16"
Bearings, Running Clearance	.003-.004"
Rod, End Clearance	.005-.012"
Bolts, Number	4
Bolts, Material	Nickel Steel
Bolts, Size	½"
Bolts, Torque Wrench, Ft. lbs.	70
Removable from Bottom of Block	Yes

j. *Crankshaft*—

Counterbalanced	Yes
Drilled for Pressure Lubrication	Yes
Bearing Journal	3.4980-3.4985″

k. *Crankshaft Bearings*—

Number	7
Material	Babbitt over Copper-lead Steel Back
Total Length, Front	1⅞″
Total Length, Intermediate (2-3-5 & 6)	1⅝″
Total Length, Center Thrust	3.118 to 3.120″
Total Length, Rear	2-1/16″
Running Clearance	.003 to .004″
End Clearance	.008 to .012″
Bolt Size	¾″
Bolts, Torque Wrench, Ft. lbs.	150

l. *Camshaft*—

Bearings, Number	4
Bearing Material (Steel Back)	Babbitt, Steel Back
Bearing Journal Diameter, Front	2.618-2.619″
Bearing Journal Diameter, 2nd	2.4305-2.4315″
Bearing Journal Diameter, 3rd	2.3680-2.3690″
Bearing Journal Diameter, Rear	1.9305-1.9315″
Running Clearance	.0015-.0035″
Bearing Length, Front	2-5/16″
Bearing Length, 2nd	2″
Bearing Length, 3rd	2″
Bearing Length, Rear	1-5/16″
Thrust Plate Material	Grey Iron
End Clearance	.005-.011″
Service Bushings	Reamed to Size
Camshaft Drive	Helical Gear
Pressure Lubricated	Yes

m. *Valves*—

Valve Seat Width	3/32″
Valve Seat Angle	45°
Valve Seat Insert	None
Stem Guides	Replaceable
Tappet Clearance, Hot	.018″
Valve Spring, Free-Length	3-1/16″
Valve Spring, Test	65 lbs. at 2½″
Valve Lever Shaft, Diam.	.9660-.9665″
Valve Lever Clearance in Bushing	.0015-.0020″
Valve Lever Bushing, Reamed to Size	No

n. *Intake Valves*—

Valve Head Diameter	2″
Valve Port Diameter	1.780″
Stem Diameter	.4325″
Stem Clearance in Guides	.002-.004″
Valve Lift	½″
Valve Opens	10° before T.C.
Valve Closes	25° after L.C.

o. *Exhaust Valves*—

Valve Head Diameter	1¾″
Valve Port Diameter	1.530″
Stem Diameter	.4315″
Stem Clearance in Guides	.003-.005″
Valve Lift	½″
Valve Opens	43° before L.C
Valve Closes	10° after T.C.

p. *Cooling System*—

Capacity, U. S. Gals.	27
Type Radiator	Flat Tube
Thermostats, Open	165°F.
Thermostats, Wide Open	190°F.
Water Pump Drive	"V" Belt
Water Pump Capacity, Gals. per min.	80
Radiator Fan Diameter	24″
Fan Blades	4
Fan R.P.M.	1670

NUT & BOLT TENSION DATA (FT. LBS TORQUE)	
CYLINDER HEAD	170
CONNECTING ROD	70
CRANKSHAFT	150
FLYWHEEL	65

4. ALTERNATOR

a. ***General***—The alternator is a General Electric Company, Type ATI, Frame 953E, Form HA.

b. ***Description***—The alternator is 6 pole, 60 cycle, 240 volt, 3 phase and turns at the engine speed of 1200 RPM. It is equipped with amortisseur winding.

c. ***Rating***—The alternator is rated at 50 KW, 62.5 KVA, 0.8 power factor, and is designed for continuous operation, and will operate on 25% overload for two hours. The output during this overload is 62.5 KW, 78 KVA. The current rating on 100% load is 150 amperes and on 125% load is 187 amperes.

d. ***Temperature Rise***—On 100% continuous load, the maximum temperature rise is 40°C. (104°F.) on the stator measured by thermometer, and 50°C. (122°F.) on the rotor, measured by the resistance of the windings. On the 25% overload the respective figures, measured in the same manner are 55°C. (131°F.) and 65°C. (149°F.).

e. ***Insulation***—Class A insulation is used.

f. ***Bearings***—The rotor runs on one ball bearing and a piloted ball bearing in the engine flywheel.

g. ***Frame***—The frame is drip proof, semi-enclosed, self-ventilated and is flange mounted to the engine flywheel housing.

5. EXCITER

a. ***General***—The exciter is General Electric Company, Type BG, Frame 78.

b. ***Mounting***—The exciter is top mounted, belt-driven from the alternator rotor shaft to run at 2000 RPM.

c. ***Rating***—The exciter is rated 1.5 KW and 23.4 amperes at 64 volts. It is shunt wound.

d. ***Frame***—The frame of the exciter is of drip proof design.

6. COUPLING

a. The alternator is coupled to the engine through an Ajax, Type BO, 3⅛ flexible coupling with an SKF #2307 pilot ball bearing. The flange half of the coupling is bolted to the engine flywheel, and the hub half is pressed on and keyed to the alternator shaft. Steel pins in the half attached to the alternator engage rubber-bushed bronze bearings in the flywheel half of the coupling. The resiliency of the rubber bushings provide the flexible feature.

7. STEEL BASE

a. The engine and alternator are mounted on a welded structural steel base constructed of 8x6½ inches, 24 pound per foot, ship channel. These side channels have skid ends and are spaced by three cross pieces of 3 inch pipe, welded in place. The channels are drilled so that the base may be bolted to its foundation. Four lifting lugs with 1½ inch eyes are welded to the base. The dimensions are as follows:

Length—102¾″
Width—34″
Height—8″
Weight—490 lbs.

8. ENGINE INSTRUMENT PANEL

a. ***Location*** — The engine instrument panel is mounted on the flywheel housing. (See fig. 3-A.)

b. ***Instruments*** — A battery charging ammeter, a water temperature gage, a lubricating oil pressure gage and a starting button switch, are mounted on this instrument panel. On some generating units the water temperature gage is graduated in degrees, and in others it may be marked in three color sections of white, green and red. In this case the dividing line between the white and green corresponds to 170°F.; the line between green and red 200°F., and the end of the scale corresponds to 220°F. Similarly, the oil pressure gage may have a red section and a white section. The range of the red section is from 0 to 15 pounds per square inch, and that of the white section is from 15 to 75 pounds per square inch.

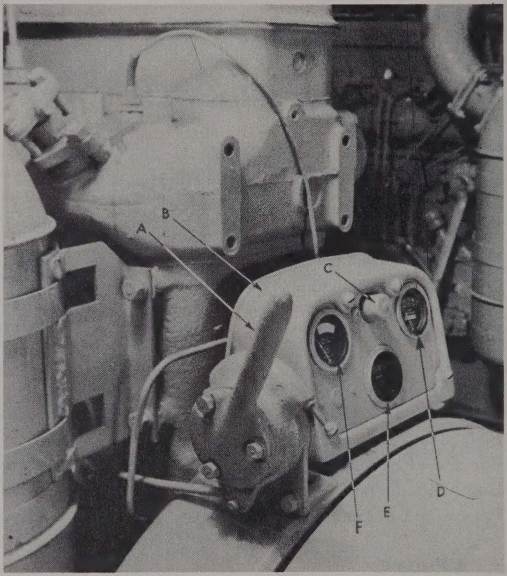

FIG. 3A
ENGINE CONTROL AND INSTRUMENT PANEL

A—Engine Speed Control Lever
B—Engine Instrument Panel
C—Electric Starting Switch
D—Water Temperature Gage
E—Battery Charging Ammeter
F—Oil Pressure Gage

9. THROTTLE CONTROL

a. A throttle control is provided for adjustment of the speed of the engine, should this be necessary. It operates by moving a fuel control rod, the movement of which changes the amount of fuel oil made available for combustion. (See fig. 3-A.)

10. SAFETY DEVICES

a. *Description*—A Fulton-Sylphon #530 combination high cooling water temperature and low lubricating oil pressure engine shut off valve is located on the left side of the engine opposite number one cylinder. See fig. 4. If the temperature of the cooling water reaches 205°F., or the lubricating oil pressure drops to 25 pounds, a tripping mechanism is caused to operate. This shuts off the fuel oil supply and opens a valve which drains the fuel oil between the control and the injection pump, thus causing immediate shut down of the engine. The control is self-operated and requires no auxiliary power for operation.

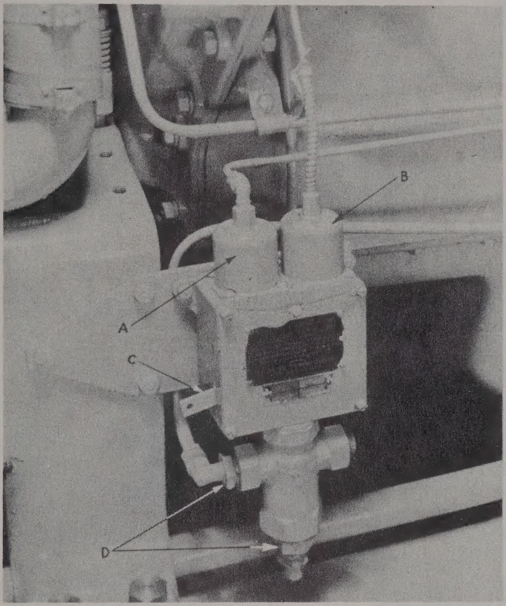

FIG. 4 — SAFETY SHUT DOWN DEVICE

A—Low Lubricating Oil Section
B—High Water Temperature Section
C—Tripping Trigger
D—Fuel Oil Connections

11. CONTROL CABINET AND CIRCUIT BREAKER

a. *Description* — The control cabinet and circuit breaker are mounted on a separate base from the engine and alternator unit. See fig. 5. The circuit breaker is in a housing bolted to the base, and the control cabinet is bolted to the top of the circuit breaker housing. This unit is electrically connected to the alternator by cables run in a flexible metal conduit which permits the movement of the control unit into convenient operating positions.

b. *Control Cabinet*—The control cabinet contains the following equipment:

1—General Electric, Type GA-37, Voltage regulator.
1—General Electric, Type 8 AW-40, ammeter, 0-200 scale.
1—General Electric, Type 8 AW-40, voltmeter, 0-300 scale.
1—General Electric, 2 to 1 potential transformer.
1—General Electric, current transformer.
1—General Electric, exciter field rheostat.
1—General Electric, compensating rheostat.

c. *Circuit Breaker*—The circuit breaker is a General Electric Type AE-1A, 3 pole, 175 ampere, 250 volt, manually operated, air circuit breaker, with two magnetic overload trip coils. It is located in the housing below the control cabinet.

d. *Parallel Operation*—As noted under A-3-*b,* the alternator is equipped with amortisseur winding. The control is designed for parallel operation, and two synchronizing lamps and a double pole, single throw switch are installed in the breaker housing.

12. WEIGHTS AND DIMENSIONS

The weight of the generating unit is as follows:

Engine and accessories	3420 lbs.
Alternator, Exciter and Control Cabinet	1690 lbs.
Base	490 lbs.
Total	5600 lbs.

The overall dimensions of the complete unit are as follows:

Length, including control cabinet, etc.	119 in.
Width, including control cabinet base	41 in.
Height	69½ in.

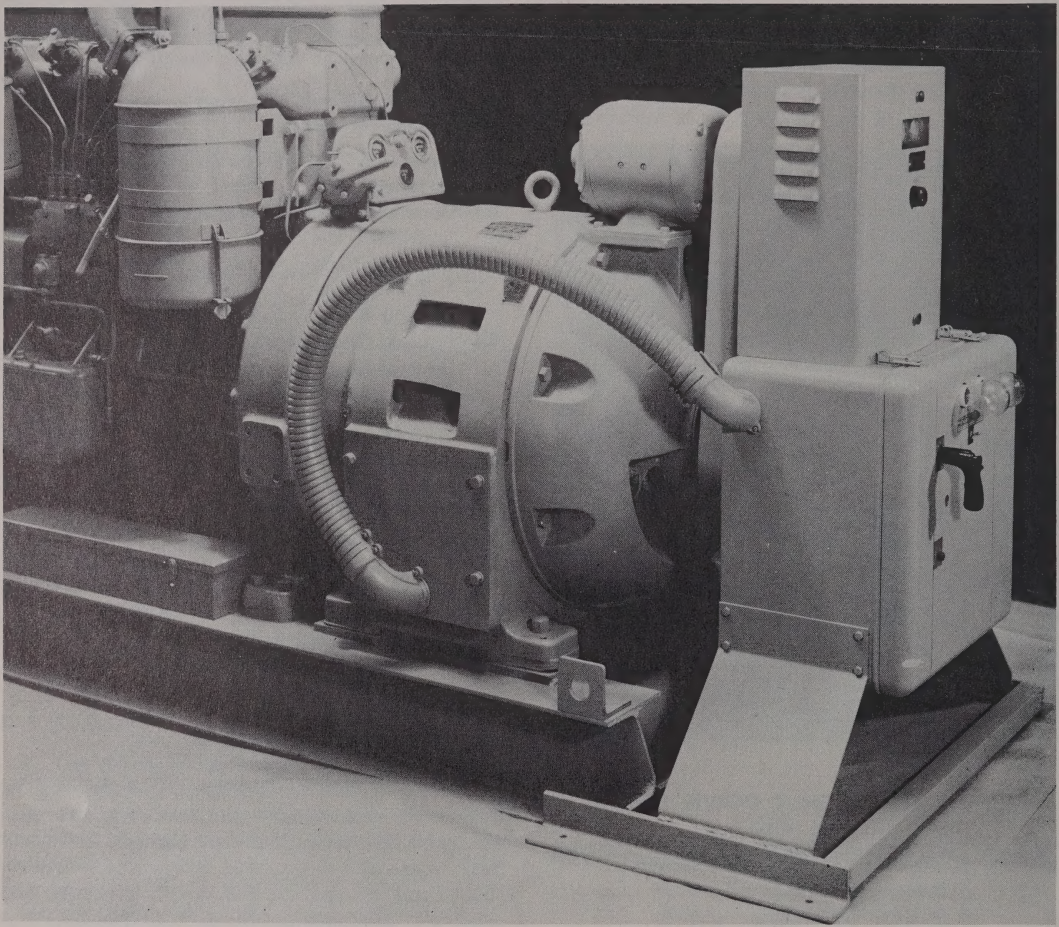

FIG. 5 — CONTROL CABINET AND CIRCUIT BREAKER UNIT

B. INSTALLATION

1. UNCRATING

a. The generating unit requires two cases for shipment, numbered Case No. 1 of 2 and Case No. 2 of 2. Case No. 1 includes the power unit; control panel; batteries; exhaust silencer; a length of flexible metal exhaust hose; two lengths of copper tubing; wiring diagram; tool box and tools and spare parts. Case No. 2 contains only the electrolyte for the two storage batteries. Two copies of the packing list are tacked to the outside of Case No. 1 and one copy is tacked inside of this case. A copy of this packing list must be carefully preserved as the first step after opening the cases is to check all parts and tools against this list. A copy of the packing list appears in the appendix of this manual. All uncrating must be done very carefully as otherwise damage to parts and delicate instruments will result. The top of Case No. 1 should be removed first and the containers of spare parts taken out. If the contents of these cartons are not checked immediately be careful not to mislay them. A great deal of care has been taken by the supplier to see that they are complete and the contents should agree with the list. After the spare parts cartons are removed proceed with the dismantling of the crate to release the unit. The caution regarding using care in doing this is repeated and particular care must be used in removing the bracing on the control cabinet end of the case.

2. PLACING UNIT ON FOUNDATION

a. ***Location***—If possible select a location for the unit that can be well ventilated. However, in placing the unit, the location of the fuel oil supply tank has to be considered. If this tank is located below the level of the unit, the following conditions must be met: Note—The engine is equipped and adjusted for this method of installation and it should be used wherever possible. See fig. 6.

(1) Maximum horizontal distance supply tank to supply pump on the engine . . . . 30 feet.

(2) Maximum height, bottom of supply tank to crankshaft of the engine . . . . 8 feet.

(3) The ⅜ inch suction pipe to the supply pump and the ½ inch overflow return pipe to the tank must slope downward to the tank and the supply

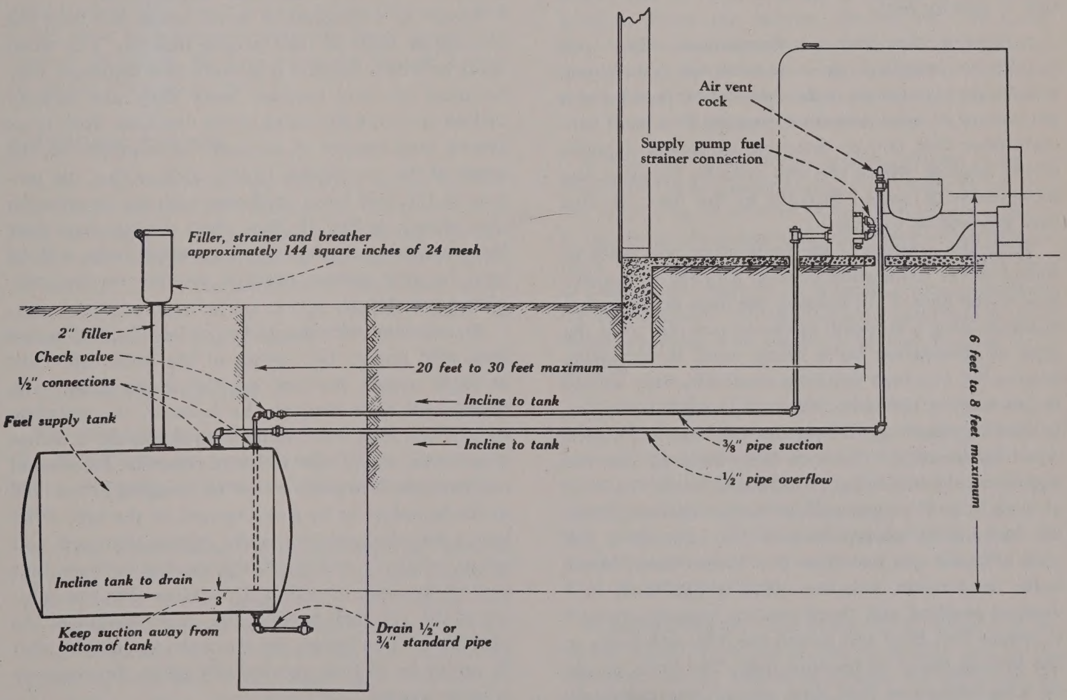
Air vent cock
Supply pump fuel strainer connection
Filler, strainer and breather approximately 144 square inches of 24 mesh
2" filler
Check valve
½" connections
Fuel supply tank
20 feet to 30 feet maximum
Incline to tank
Incline to tank
⅜" pipe suction
½" pipe overflow
6 feet to 8 feet maximum
Incline tank to drain
3"
Keep suction away from bottom of tank
Drain ½" or ¾" standard pipe

FIG. 6 — SUGGESTED METHOD OF INSTALLATION OF FUEL OIL STORAGE TANK

pipe must be equipped with a check valve, located near the tank, to prevent the fuel oil draining back into the tank when the engine is shut down.

(4) The supply pipe should project into the tank from the top to a distance 3 inches from the bottom of the tank.

(5) The tank should be equipped with a drain pipe and a valve or cock and should be slightly lower at the drain cock end.

(6) The filler pipe should be at least 2 inches and should be equipped with a breather and strainer. The strainer should be 24 mesh wire and have approximately 144 square inches of surface.

b. Gravity Installation—In case the supply tank is located for a gravity feed, the supply pipe must enter the tank from the bottom and project 3 inches into the tank and should be equipped with a shut off valve near the tank. No check valve, as referred to in No. 3 on preceding page, should be used. Also provision must be made to take care of the overflow from the injection pump by running a ½ inch pipe from the day tank to the *top* of the supply tank. This pipe must not project into the supply tank, as, to do so, might start a syphon. The maximum height from crankshaft of the engine to the top of the supply tank for this type installation is 20 feet. All openings of the day tank must be closed if installation is gravity feed.

c. Placing the Unit on Foundation — The unit should be installed on a substantial foundation, preferably of concrete if the installation is to be of a permanent or semi-permanent nature. If a good concrete floor slab, laid on firm soil, is already in place in the location where the unit is to be installed, the latter may be bolted directly to the floor. In this case proceed as follows:

Mark the position of the foundation bolt holes as shown in the foundation plan on Fig. 35, on the surface of the floor. Drill holes in the floor at the points marked, using a star drill of the correct size to fit the type of foundation bolts being used. If expansion sleeves for 1¼ inch bolts are available, they should be inserted in the holes, the unit moved into place, leveled by inserting shims under the base and bolted down by means of 1¼ inch bolts screwed into the expansion shields, using a lockwasher under the head of each bolt. If expansion sleeves are not used, drill the holes large enough to take the head of a 1¼ inch bolt and not less than 6½ inches deep. Insert bolts, head down, into the holes, wedge them in a vertical position and check spacing between centers to insure that they will match the 1½ inch holes in the bottom flange of the unit base. The bolts should be long enough so that they project approximately 2½ inches above the top of the floor. Then seal the bolts in place in the holes by molten lead or cement grout mixed in accordance with instructions in section B-2-d, Grouting In.

After the sealing material is thoroughly hard (10 to 14 days if cement grout is used), turn a nut on each of the six bolts, place a plain washer on top of each nut and set the generating unit in place so that the weight is supported by the nuts and each bolt extends approximately 1 inch through the hole in the lower flange of the unit base. The unit should then be leveled carefully by raising or lowering the nuts on which the base is resting. The nuts should be adjusted so that each is supporting its share of the total weight of the unit. Then place a lockwasher and nut over each bolt and turn nuts down tightly to hold the unit in place. The space between the top of the floor and the bottom of the unit base should then be filled with cement grout to provide an even support under the entire length of each of the steel base skids as described in section B-2-d.

If a new foundation is to be built for a permanent or semi-permanent installation, proceed as follows:

Excavate the soil below the selected location for the generating unit to a depth of approximately one foot over an area 34 inches wide by 83 inches long if the soil is firm. If the soil is loose or soft, the depth and bearing surface of the foundation should be increased to suit the conditions encountered.

Make up a template of wood which will hold the foundation bolts in their proper location. The wood skids on which the unit is mounted for shipment may be used for this purpose since they are already drilled to match the holes in the unit base. Nail cross pieces, long enough to support the template on the edges of the excavation, to the skids so that the pattern of the bolt holes conforms with the foundation plan shown on Fig. 35. Now place the template over the excavation so that the foundation bolts will be held in their proper position relative to the completed foundation.

Foundation bolts should be not less than 12 inches long with one or two inches of the lower end bent at right angles, forming an "L" shape. Insert the foundation bolts through the holes in the template so that the tops will extend approximately 3 inches above the top of the finished concrete foundation and hold them in place either by wedging in the hole in the template or by a nut turned on the top of the bolt. Level the template, make certain that each bolt hangs vertically and check the spacing between bolt centers to make sure that it matches with the spacing of the 1½ inch holes in the lower flanges of the unit base. Then fasten the template in place so that it cannot be shifted accidentally when the concrete is being placed.

Concrete should be proportioned of one part Portland cement by weight to two parts coarse sand and 3 parts gravel or crushed stone. Mix thoroughly with only enough water to obtain a workable mix. If the soil is loose, wood forms should be placed along the sides and ends of the excavation. If the soil is firm, forms need not be used. Compact the concrete thoroughly by tamping while it is being poured and work it carefully around the foundation bolts to prevent shifting them from their proper position. Level off the top of the concrete and leave it rough. Allow the concrete to set thoroughly before removing the template and keep the top damp for at least 10 days to insure proper curing. The unit may then be set on the foundation bolts and leveled by the use of jacking nuts as described in a preceding paragraph. Bolt the unit down tightly and grout in as described in Section B-2-d, first cleaning the surface of the concrete foundation thoroughly and dampening it.

If the installation is to be temporary, the unit may be bolted to a substantial timber frame work. It should be leveled properly before putting into operation.

d. *Grouting In* — Make a grout mixture of one part of cement to one part of sharp sand mixed with only sufficient water to give a thick liquid which can be worked easily. Build a wooden dam around the base approximately 3 inches high. Pour in the grout until it covers the lower section of the channel, using a flat stick to push and tamp the grout under the base at all points. Be sure the grout has set before removing the wooden dam.

3. CONTROL CABINET

a. As described in section A-11 the circuit breaker and control cabinet are mounted on a separate base from the engine and alternator and this control unit is movable within the limits of the flexible conduit connecting it to the alternator. Sufficient space should be available to move this control cabinet to a convenient operating position.

4. CONNECTION OF UNIT

The next step after the unit is in place is to make the connections for fuel oil, exhaust to the atmosphere, the radiator duct and the electrical connections.

a. *Fuel Connections* — The accessory equipment, furnished with each unit, includes a 20 foot length of 3/8 inch and a 20 foot length of 1/2 inch copper tubing and 3/8 inch and 1/2 inch standard pipe couplings. Using the 3/8 inch tubing connect the fuel oil strainer located forward and on the right hand or manifold side of the engine, to the tank and using the 1/2 inch tubing connect the overflow from the day tank to the supply tank as described in section B-2-*a* and shown in Fig. 6. Before making the connection to the supply pump it will be advisable to fill the suction line with fuel oil. This can be done by pouring fuel oil with a funnel and bucket or equivalent, into the line until it is completely filled. It will also be advisable to fill the day tank.

b. *Exhaust Connections*—Install the inverted "Y" section of the exhaust manifold by bolting it to the outlets of the two manifolds on the engine, using gaskets which are provided. Accessory equipment for the exhaust system includes the following:

1—36 inch length of 3 inch flexible metal hose with 3 standard pipe nipples welded on each end. Chicago Metal Hose Type RW 89.
1—Exhaust silencer, Burgess Model STC-3.
2—10 foot length of 3 inch black pipe, threaded both ends.
2—3 inch—90° elbows.
4—3 inch black iron couplings.

The flexible metal hose must be connected to the single outlet of the "Y" section which has a male thread for a 3 inch fitting. A coupling or an elbow can be used, whichever works in best with the position of the exhaust silencer, which should be installed at the other end of the metal hose. This silencer may be used in either a vertical or horizontal position. From the exhaust silencer run the necessary length of iron pipe to carry the exhaust gases to the atmosphere. After the engine is put in operation check all of these connections for leaks. It is important that no leaks exist in this system.

c. *Cooling System*—The cooling system must be filled with water. Before doing this, check to see that the drain plug located in the bottom of the radiator is tightly in place and that all hose connections are tight. While filling the system open the vent cock or plug on the thermostat housing, which is between the first cylinder and the radiator, and close it when water appears. The capacity of the system is 27 gallons.

d. *Air Intake*—The intake air filter, as previously noted, is the oil bath type. Before starting the unit, remove the lower section of this filter and fill the section with lubricating oil up to the indicated level, which is plainly marked. The same oil as is used in the crankcase will be satisfactory for the filter. In replacing this reservoir section of the filter be sure that all joints are tight.

e. *Lubricating Oil*—The proper SAE rating of lubricating oil must be put in the crankcase and in the injection pump. The SAE grades for different atmospheric temperature conditions are listed in paragraph C-4-d in the "Adjustment and Operation" section of this manual. Select the proper grade to meet the existing conditions. The filler to the crankcase is located forward and to the left of the first cylinder. Twenty-two (22) quarts of oil will be required for the crankcase. Lubricating oil must be put in the injection pump housing to lubricate the pump camshaft and the governor. First drain all oil out by removing plug marked "Drain." Replace this plug and remove the plug from the filler marked "Oil" and put in 3/8 of a pint (6 ozs.) of the same grade of oil used in the crankcase. *Use only oil of known high quality.*

f. *Canvas Air Duct*—The radiator is provide with a metal frame to which a canvas, or other material, duct can be attached to direct the hot air upward or to the atmosphere as desired. If a metal duct is used, it is recommended that a short section of flexible material such as canvas be installed between the frame on the radiator and any such metal duct. The frame is drilled to facilitate the installation of any such equipment. Duct material is not part of the equipment and is not supplied.

g. *Batteries.* NOTE: *Take good care of the batteries. Certain starting of the engine on short notice will be doubtful if the batteries are neglected.*

(1) The storage batteries, 2 in number, which are part of each unit are shipped dry but with the plates in a charged condition. The vent plugs for each cell are screwed tight with sealing discs and must remain so until the cells are filled with electrolyte which is supplied with each unit.

(2) Before using, the batteries must be filled with the electrolyte. If it is necessary to prepare this solution, it is made by adding very slowly 1 part by volume of concentrated sulphuric acid (1.835 sp. gr.) to 2.8 volumes of distilled water (if available), resulting in a solution of 1.275 sp. gr., which is correct for use in temperate climates. If distilled water is not available, water that is fit to drink is generally acceptable. For tropical climates the solution should be made of 1 part acid to 3.5 parts of water which will give a solution of 1.240 sp. gr. Do not use metal containers for mixing the solution. Stir constantly while mixing the solution. It will require slightly less than 3 gallons of solution to fill the two batteries to the proper level.

CAUTION: *Acid must always be added to water, and added slowly. Never add water to the acid.*

CAUTION: *If acid is spilled on the flesh or clothing, wash immediately with ample cold water.*

Allow the electrolyte solution to cool to room temperature before using.

(3) To fill the batteries, unscrew the filler plugs and remove sealing discs on top of filling holes or under caps and discard same. Make certain that all vent holes in each plug are open. Then fill batteries to 3/8 inch or 1/2 inch above separators with the electrolyte. Let batteries stand about an hour, and if the level of the solution has fallen, add more of the electrolyte to restore the level. Replace plugs, wipe any spilled electrolyte from top of batteries and coat the battery terminals and terminals on the end of battery cables with petrolatum (vaseline).

(4) Battery can now be put in service if urgently needed. When time and equipment permit, an initial charge by external means for 16 to 20 hours at 12 amperes is recommended before placing in service. For this initial charge, series charging must be used; never constant potential. The batteries are fully charged when all cells are gassing or bubbling freely and the specific gravity of all cells has shown no further rise during three hours.

(5) If no external charging means is available, the batteries should be put in service on the unit, if necessary starting the unit by hand cranking. The charging rate of the battery charging generator in the unit is approximately 8 amperes, and 20 hours running should result in charged batteries.

(6) If the generating unit is operated in very cold temperatures, and if the unit is not going to be used for a period of hours, it is best to remove the batteries to a warm place as battery efficiency decreases rapidly with the cold.

h. *Battery Connections*—The two batteries shipped with each unit are installed in the place provided on the right hand side of the engine and connected in series in order to obtain the 12 volts necessary to operate the starting system of the engine. This is done by connecting the positive terminal of one battery to the negative terminal of the other. The remaining positive and negative terminals are connected as follows:

(1) The positive pole is connected to the metal of the engine with the cable already installed for that purpose.

(2) The negative pole is connected to the cable already installed which leads to the electric starter switch on the instrument panel.

NOTE: The battery terminals are marked positive and negative. The usual marking for the positive terminal is either a + sign; the letters POS, or the terminal may be painted red. The negative terminal may be marked with a — sign or the letters NEG, or it may have no designating marks at all.

CAUTION: *Before making any electrical connections and before operating the unit, take off the control cabinet cover and remove the protective wrapping from the voltage regulator stack and the control magnet. This has been placed there to protect the* *adjustment of these parts during transit. See section D-43, and figures referred therein.*

i. *Electrical Connections*—As previously noted the output of the alternator is three wire, 240 volts. (A fourth wire neutral is provided to give 138 volts but this connection is taped and not brought out of the alternator.) The alternator and exciter leads are permanently connected to the alternator and the exciter and are run from these to the control cabinet through a Greenfield or flexible metal conduit which, as described in section A-11, permits the placing of the control cabinet in a convenient location for operation of both the engine and the electrical control instruments. Provision is made for fastening this conduit to the side of the circuit breaker housing and the leads, of course, enter the cabinet through this opening. Fig. 7 and 8 shows the wiring diagram. If it is desired to place the control cabinet further from the generating unit than the length of flexible conduit will permit new cables will have to be run or extensions installed on the present leads. In order to make the new circuit breaker and field rheostat connections it will be necessary to remove or swing out the circuit breaker. To do this proceed as follows: Refer to Fig 8.

(1) Remove the synchronizing bulbs, (A).

(2) Remove the circuit breaker reset handle, (B), by unscrewing the knurled fastener (C) and then slide the handle off.

(3) Unfasten the four catches (D) holding the circuit breaker cover on top and bottom and remove the cover.

(4) Remove the two cap screws (E) holding the breaker panel at the top. It is *not* necessary to remove or loosen the two lower bolts.

(5) Grasp the circuit breaker panel firmly at the top and pull it forward. The panel is pivoted on the two lower brackets and can be swung out or lifted out completely.

CAUTION: *In lifting the circuit breaker out be very careful not to injure the oil dashpots.*

Alternator leads and the terminals of the circuit breaker are marked with identifying numbers. Connect leads No. 1 and 3 to the upper terminals of the circuit breaker numbered 1 and 3. A connection is already made from the No. 2 terminal of the breaker to one side of the primary of the transformer (E). The No. 2 alternator lead must be connected to the other side of the transformer primary. Note that the potential leads from terminals No. 1 and 2 on the terminal block are inserted with the alternator leads in terminals No. 3 and 1 of the circuit breaker. See

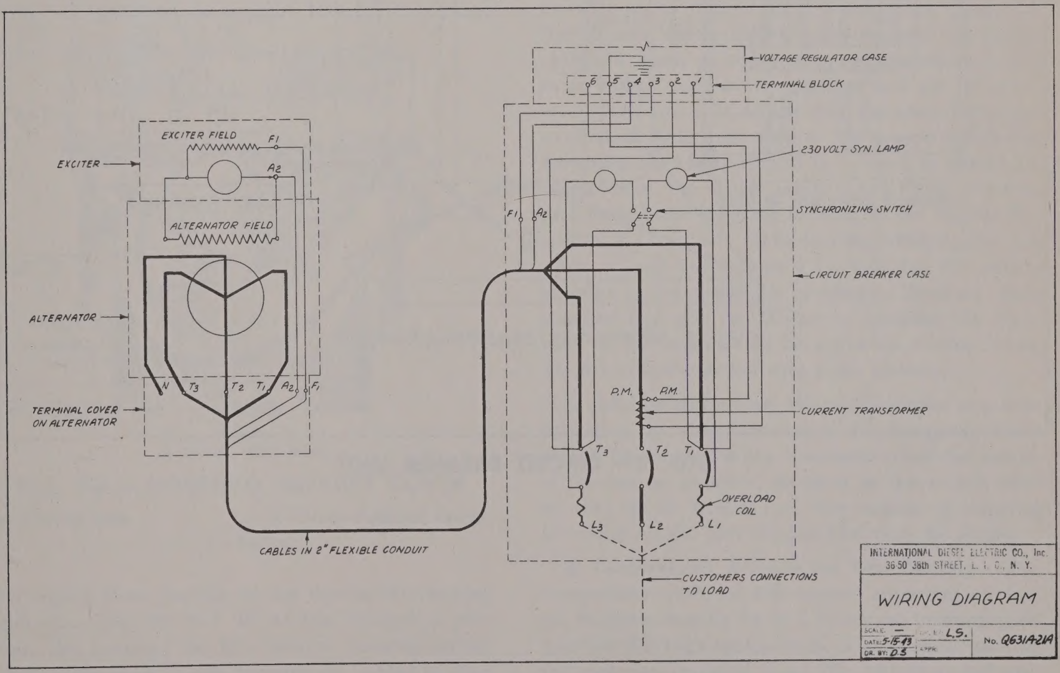
VOLTAGE REGULATOR CASE
TERMINAL BLOCK
6
5
4
3
2
1
EXCITER FIELD
F1
A2
EXCITER
ALTERNATOR FIELD
230 VOLT SYN. LAMP
SYNCHRONIZING SWITCH
F1
A2
CIRCUIT BREAKER CASE
ALTERNATOR
N
T3
T2
T1
A2
F1
TERMINAL COVER ON ALTERNATOR
P.M.
P.M.
CURRENT TRANSFORMER
T3
T2
T1
OVERLOAD COIL
L3
L2
L1
CABLES IN 2" FLEXIBLE CONDUIT
CUSTOMERS CONNECTIONS TO LOAD
INTERNATIONAL DIESEL ELECTRIC CO., Inc.
36-50 38th STREET, L. I. C., N. Y.
WIRING DIAGRAM
SCALE: —
L.S.
DATE: 5-15-43
DR. BY: D.S
APPR:
No. Q631A21A

FIG. 7 — CONNECTION DIAGRAM

fig. 7. These must be restored if they have been disconnected during making the connections from the breaker to the alternator. The exciter field leads are connected to terminals No. 3 and 4 of the terminal block and from these points connections are made to the exciter field rheostat. The leads are marked F1 and A2 on the wiring diagram fig. 7. If extension or new leads are run from the exciter field they must be connected to terminals No. 3 and 4 as shown.

j. ***Load Connections*** — The load connections must be made to the three lower terminals of the circuit breaker. Load leads are brought into the circuit breaker through the opening provided in the bottom of the circuit breaker housing.

k. ***Parallel Operation Connections*** — For parallel operation, the marked lower terminals of the circuit breaker of each generating unit are connected to the correspondingly marked terminals of the other units.

l. ***Grounding*** — Connect the frames of the power unit and the control cabinet to a low resistance ground such as a pipe or rod driven into moist earth. The ground cable should be large enough so that it will not fuse under a sustained short circuit between the line and ground. A good rule to follow is to use a ground cable at least equal in size to the largest connection between the alternator and the control cabinet.

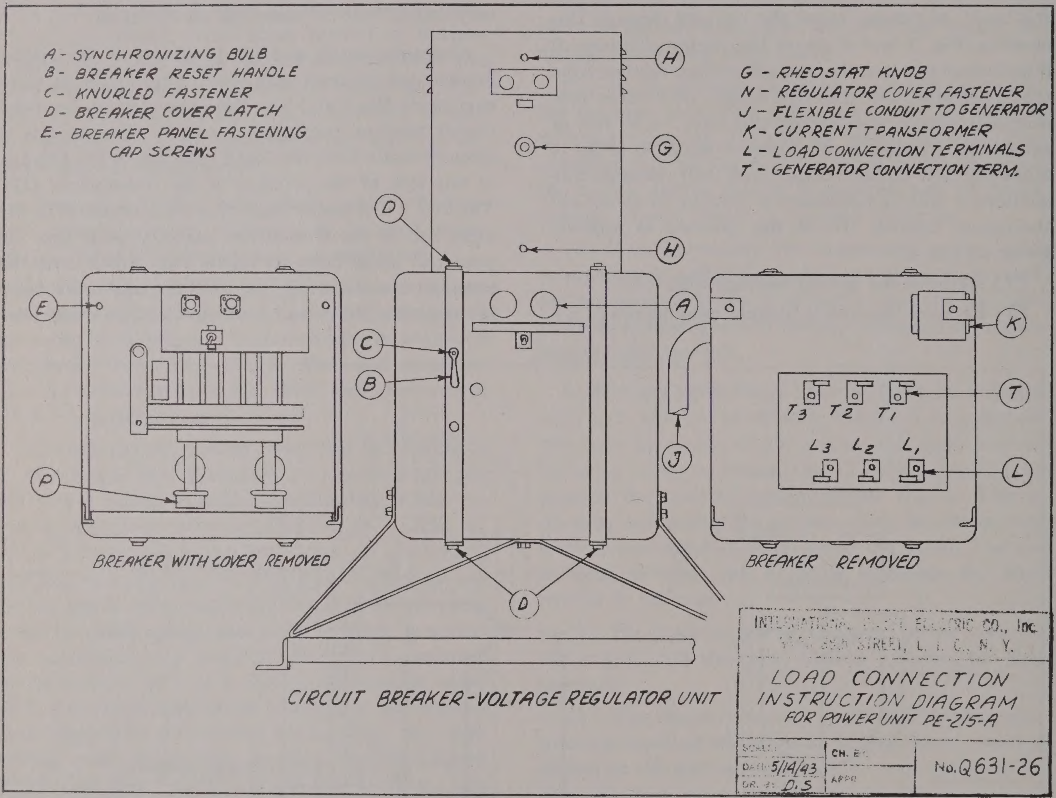
A - SYNCHRONIZING BULB
B - BREAKER RESET HANDLE
C - KNURLED FASTENER
D - BREAKER COVER LATCH
E - BREAKER PANEL FASTENING CAP SCREWS
G - RHEOSTAT KNOB
N - REGULATOR COVER FASTENER
J - FLEXIBLE CONDUIT TO GENERATOR
K - CURRENT TRANSFORMER
L - LOAD CONNECTION TERMINALS
T - GENERATOR CONNECTION TERM.
H
G
D
H
A
C
B
E
P
J
K
T
L
T_3 T_2 T_1
L_3 L_2 L_1
BREAKER WITH COVER REMOVED
BREAKER REMOVED
D
CIRCUIT BREAKER-VOLTAGE REGULATOR UNIT
INTERNATIONAL ... ELECTRIC CO., Inc.
... STREET, L. I. C., N. Y.
LOAD CONNECTION INSTRUCTION DIAGRAM FOR POWER UNIT PE-215-A
SCALE
DATE 5/14/43
DR. BY D.S
CH. BY
APPD
No. Q631-26

FIG. 8 — CIRCUIT BREAKER UNIT

C. ADJUSTMENT AND OPERATION

1. GENERAL

When units are shipped, all gasoline, fuel oil and lubricating oil has been drained from the engine and all water drained out of the cooling system. The storage batteries are charged but shipped dry.

CAUTION: BEFORE ATTEMPTING TO PUT THE UNIT IN OPERATION:

(1) LUBRICATING OIL *MUST* BE PUT IN THE CRANKCASE. SEE C-4-c AND C-4-d.

(2) THE COOLING SYSTEM *MUST* BE FILLED WITH WATER.

(3) GASOLINE *MUST* BE PUT IN THE GAS TANK.

(4) CONNECTIONS TO THE FUEL OIL STORAGE TANK *MUST* BE MADE.

FAILURE TO BE SURE OF (1) AND (2) MAY CAUSE SERIOUS DAMAGE TO THE UNIT.

2. FREEDOM OF MOVING PARTS

It is advisable to turn the engine over several times, by using the hand crank, to determine whether all parts are free; that the fan clears the radiator and guard, etc. If gasoline has already been put in the small tank fastened to the radiator, it will be necessary to ground the magneto in order to prevent the engine from starting during this hand cranking operation. (See fig. 8*a*.) To do this, connect a wire from the terminal on the breaker housing cover, which is the metal cover beneath the cables leading to the spark plugs to some point on the engine where a convenient connection can be made. The connection to the engine frame or part should not be made near the carburetor or near the gasoline tank. The same result will be obtained if the distributor is removed. It is held in place by two spring clamps which fit in recesses in the distributor housing. Releasing these clamps will permit the easy removal of the distributor. It will be necessary to reduce the compression of the engine to that for gasoline operation by throwing the compression release lever to its forward position.

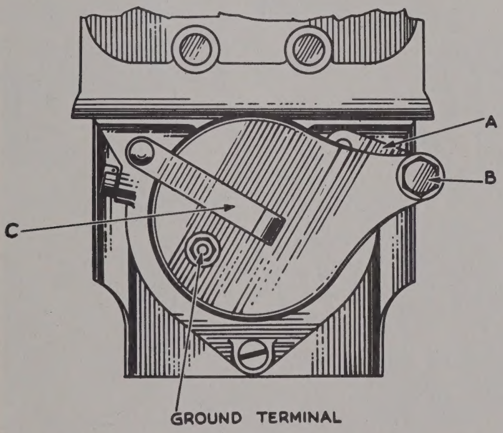

FIG. 8-A — MAGNETO BREAKER COVER

A—Timing Link B—Pivot Point of Cover C—Spring

3. GASOLINE STARTING SYSTEM

a. *General*—As stated in the foregoing section of "Description of Equipment" the engine is equipped with a gasoline and ignition system similar to that of the typical automobile except that a magneto supplies the high voltage to the spark plugs instead of the usual battery and spark coil. The magneto has a distributor of the usual automotive type.

b. *Carburetor*—The gasoline carburetor, which is part of the starting system, is equipped with a manually operated choke and a manually operated priming pump. See fig. 9. These should be used, if necessary to facilitate starting the engine. Moving the choke lever forward causes a greater quantity of gasoline to be drawn into the cylinders. Operating the priming pump injects gasoline into the intake manifold. Both or either of these operations result in a "richer" mixture of gasoline and air, which is easier fired in a cold engine than the correct mixture to produce power. As soon as the engine is running smoothly, the choke should be opened, as continued operation in the closed position will cause flooding and consequent irregular running of the engine. Excessive flooding will make starting unlikely. In this event, it will be necessary to wait for the excess gasoline in the system to evaporate. Draining some gasoline from the carburetor, by opening the drain cock at the bottom will be advisable. Never forget the fire risk connected with loose gasoline.

c. *Load on Alternator*—When the engine is put in operation, in accordance with the foregoing, there should be no load on the alternator while the engine is running on gasoline. As soon as the switch over to fuel oil is made, and the engine is running smoothly on the fuel oil, the load may be added.

d. *Compression Release for Gas Starting* — The compression ratio of the engine, operating on fuel oil, is approximately 14 to 1. However, in starting on gasoline this high compression is reduced by moving the compression relief lever, (fig. 10) in a clockwise direction, as far as possible. As it approaches the

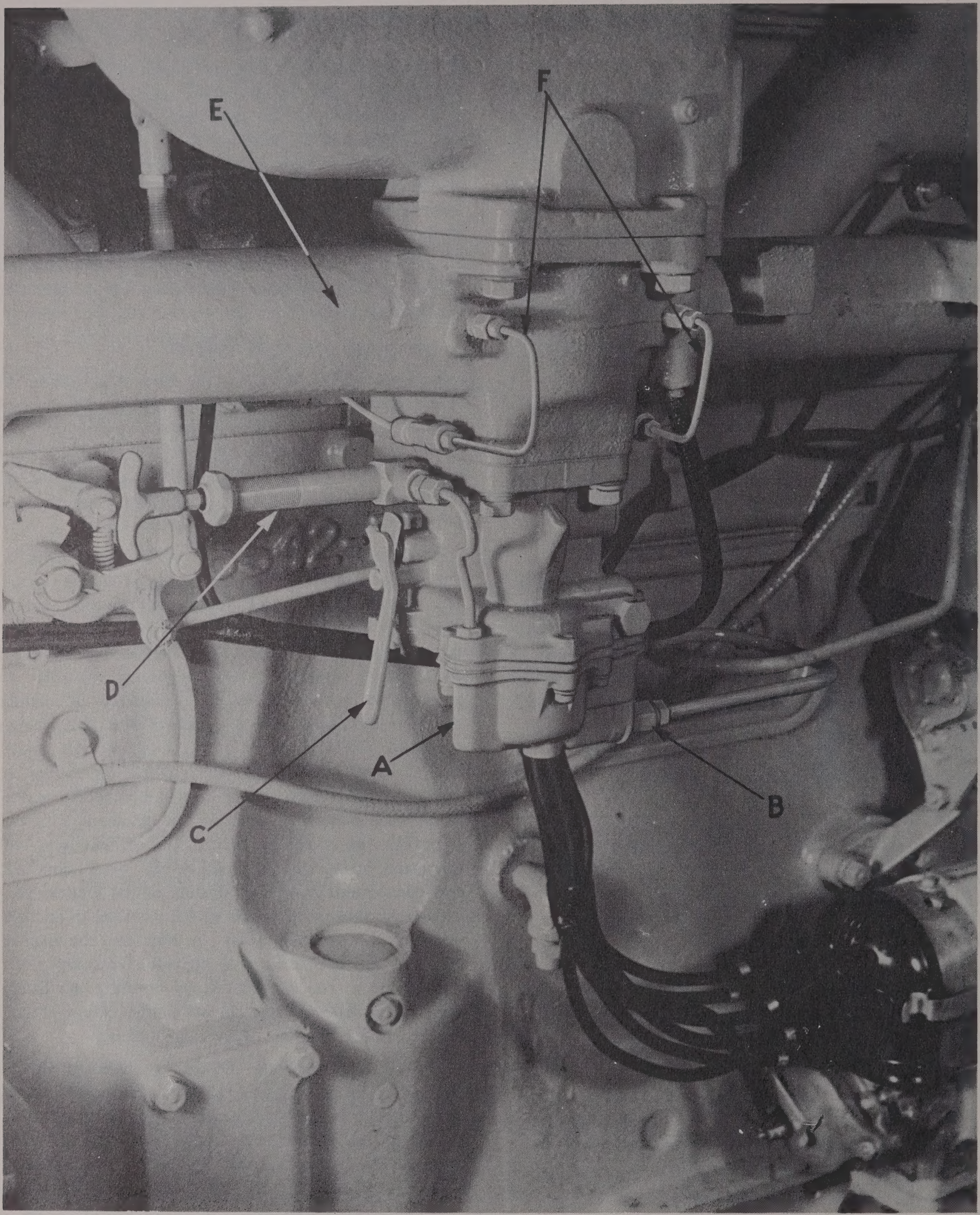

FIG. 9 — CARBURETOR

A—Carburetor	C—Choke Lever	E—Intake Manifold
B—Gasoline Strainer	D—Priming Pump	F—Priming Tubes to Manifold

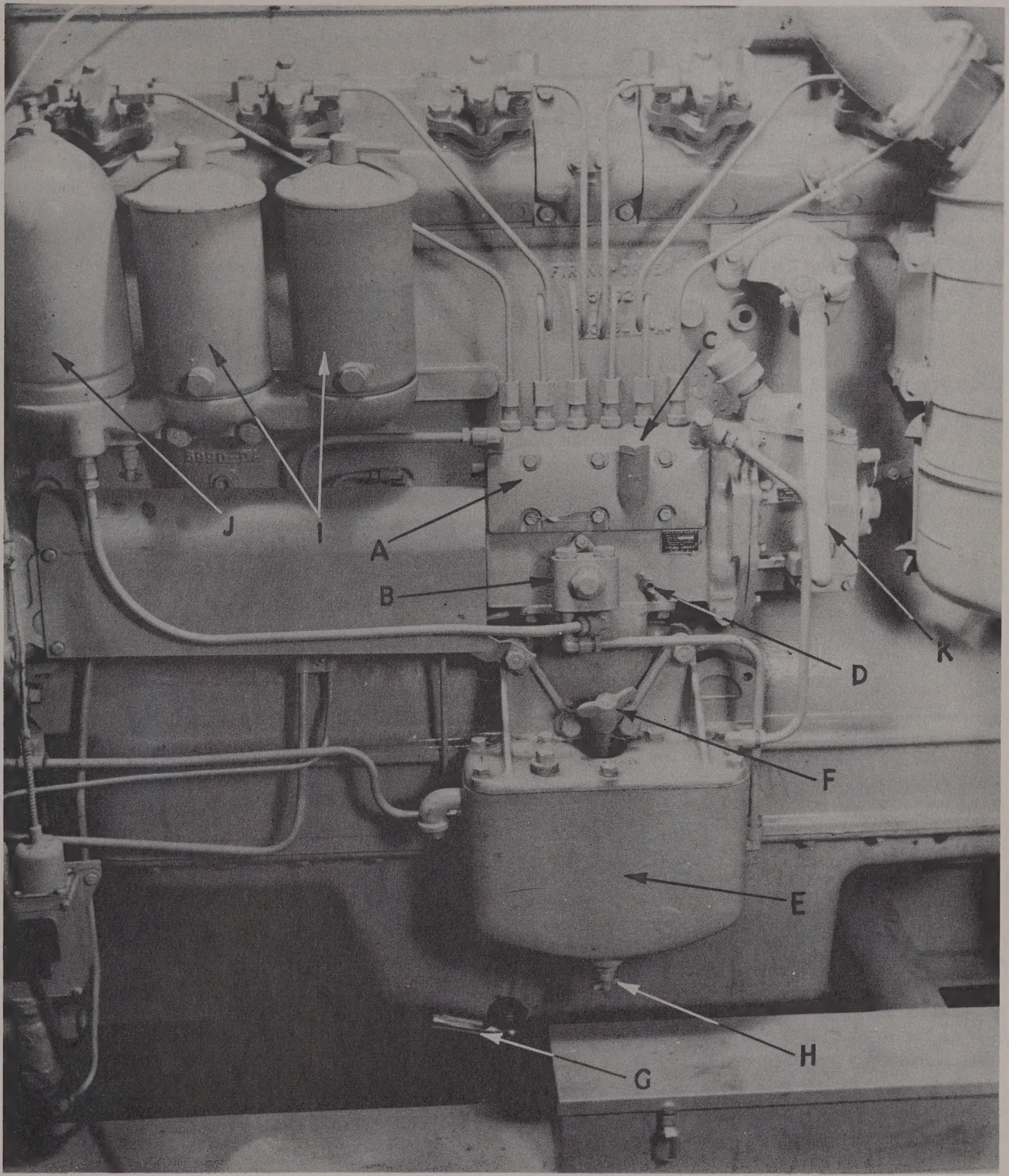

FIG. 10 — RELEASE LEVER AND FUEL OIL EQUIPMENT

A—Injection Pump
B—Transfer Pump
C—Injection Pump Lubricating Oil Filter
C—Injection Pump Lubricating Oil Drain
E—Intermediate Tank
F—Bayonet Type Gage to Crankcase
G—Crankcase Thermometer
H—Intermediate Tank Water Drain
I—Lubricating Oil Filters
J—Fuel Oil Filter
K—Compression Release Lever

proper position a click will be heard. It must be pulled slightly further than this point in order to operate satisfactorily on gasoline. The movement of the compression relief lever accomplishes four things:

(1) It opens and holds open six "starting" valves similar to any gas engine intake or exhaust valves. The opening of these valves makes available additional space in the cylinder head so that the compression ratio is reduced from about 14 to 1 to about 6 to 1, which is that of the conventional gasoline engine.

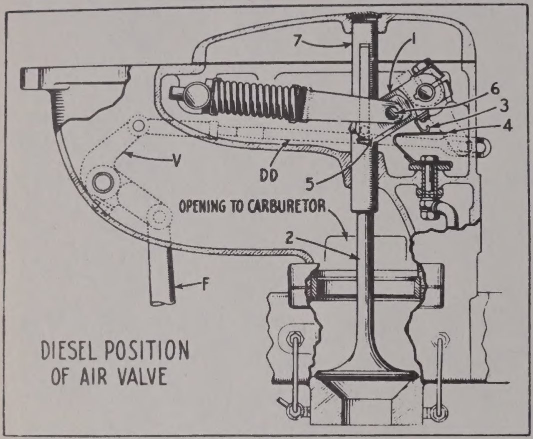

FIG. 11 — AIR VALVE

1—Valve Lever
2—Valve Stem
3—Magneto Grounding Switch
4—Insulated Contact
5—Pin Retainers
6—Pin
7—Valve Sleeve
F-V-DD—Shifting Mechanism

(2) It closes the air valve in the Diesel Section of the dual intake manifold, (fig. 11) thus directing air intake to the carburetor from which the gas and air mixture enters the cylinders, by way of the section of the intake manifold provided for this purpose, and is fired by the spark plugs.

(3) It connects the magneto electrical circuit by opening the magneto grounding switch located in front end of intake manifold.

(4) It releases a gasoline shut off valve in the carburetor, thus allowing gasoline to flow into the carburetor. NOTE: It is necessary before starting the engine to close completely the speed control lever used for oil operation. This shuts off fuel supply to the nozzles from the fuel injection pump.

This is the condition that exists and is required for starting.

e. *Gasoline to Oil Operation*—After the motor has been running as a gas engine for about one minute, the speed control lever is moved to operating position and the compression release lever is thrown counter-clockwise as far as possible. In this position the starter valves are closed, the gasoline valve in the carburetor is shut off, the magneto is cut out of the circuit and the air valve in the Diesel section of the intake manifold is opened and the engine operates as a full Diesel and all parts related to gasoline operation are inactive.

4. LUBRICATION

a. *General*—While the life of an engine depends on the care it receives, proper lubrication is undoubtedly the most important factor in insuring the long and satisfactory service that may be obtained. Excepting a serious breakage, there is nothing that is likely to happen to an engine that will cause as much damage as improper lubrication or neglect in seeing that sufficient oil is always in the crankcase and being properly circulated through the system. Seized or burned bearings, damaged crankshafts, broken connecting rods, broken piston pins and scored cylinders are a few of the serious damages that may result from faulty lubrication. The bayonet type gauge, marked "Full", "½", "¼", "Empty" is a sure check for the quantity of oil in the crankcase, and the oil pressure gauge on the instrument panel is a check on the circulation of the oil through the engine. See fig. 10.

b. *Filling Crankcase*—As noted under C-1, oil must be put in the crankcase of units when they are first put in service. There is a capped opening for this purpose located forward and on the left side of the engine under the gasoline tank. See fig. 2.

c. *Quantity of Oil Required*—The quantity of oil required is 22 quarts.

d. *Grade of Oil Recommended*—The viscosity of oil or the "number" as commonly used, is as follows for the air temperatures noted. These temperatures are, of course, the temperatures that actually exist where the unit is being operated.

AIR TEMPERATURES	CRANKCASE OIL
Above 90°F.	SAE-30
90°F. to 32°F.	SAE-20
32°F. to 10°F.	SAE-10
10°F. to Sub-Zero	10-W

It is not necessary to change the crankcase oil every time the atmospheric temperature rises or falls into another temperature range during some part of the 24-hour day. For example, SAE-30 may be used instead of SAE-20, except for starting conditions in the lower temperature ranges where SAE-20 is specified. SAE-10 may also be used up to around 40° to 45°F. atmospheric temperature, except for continuous heavy load.

e. *CAUTION*—Keep the supply of lubricating oil absolutely clean and free from dust, etc. Always use clean containers and wipe the filling sleeve clean before pouring in oil.

f. *Bayonet Oil Gauge* — The bayonet gauge is marked to indicate the level of the oil in the crankcase, both for an idle engine and an engine in operation. The marks for these two conditions are on opposite sides of the gauge as indicated thereon. The proper method of checking the oil level in the crankcase of an idle engine with the bayonet gauge is:

(1) Unscrew the wing nut which holds the gauge in place, remove the gauge from the engine and wipe it clean.

(2) Reinsert the gauge in the engine until the wing nut rests on top of the gauge sleeve threads; *do not screw nut onto the sleeve.*

(3) Remove the gauge and observe the oil level. This procedure is necessary, as during operation the gauge is splashed with oil above the mark that would indicate the actual oil level in an idle engine. For a running engine, the same procedure should be followed except that the operating side of the gauge should be observed.

g. *Oil Pressure Gauge*—The oil pressure gauge is located on the engine instrument panel. On some units the scale of this gauge is divided into a red section and a white section, and on others it may be graduated in pounds pressure. On a gauge marked in red and white, the red section covers 0 to 15 pounds and the white section 15 to 75 pounds. When the lubricating oil system is functioning properly, the indicating needle should be well in the white section, or it should indicate at least 25 pounds pressure. If the needle is in the red section, or below 25 pounds pressure, the engine should be stopped immediately and the oil system inspected to find the cause of failure. The most frequent cause of this condition is low oil or lack of oil in the crankcase. Always note the operation of this gauge when starting the engine after an idle period, and observe it frequently during the running period.

h. *Oil Circulation*—As noted in section A-2-*j*, the oil pump and floating screened oil intake are located in the crankcase. The purpose of the floating oil intake is to always supply oil to the pump from the surface of the oil in the crankcase, thus eliminating the possibility of mixing any water or sediment, should any be present, with the oil to be circulated through the system. Oil is drawn through this screened intake into the pump, by which it is pumped under pressure into the main oil circulation system. The oil is directed to the main bearings by way of drilled passages in the crankcase. From these bearings, the oil travels through drilled passages in the crankshaft to the connecting rod bearings, from where it is directed to the piston pins and cylinder walls. Oil passages also lead to the camshaft bearings and the timing gears. Another passage leads from the front camshaft bearing and extends upward through the crankcase to the valve rocker arm mechanism. The valve lever shaft which carries the rocker arms is hollow, and oil is distributed through this shaft to the valve rockers, valve stems and starting mechanism. The oil is drained back to the sump, and in so doing lubricates the valve tappets and cams, and also saturates a valve oiler pad.

i. *Oil Filters*—Two absorption type oil filters are located on a triple bracket with a fuel oil filter on the left side of the engine. (See fig. 10.) The oil filters are the two rear ones on this bracket. The oil entering the filters is bypassed from the main system. After passing through these filters, it is returned to the crankcase.

j. *Oil Pressure* — Oil pressure is controlled by a plunger type regulating valve located in the oil pump body. It is set for 60 pounds pressure.

5. AIR INTAKE

a. *General*—Clean air for combustion is assured by an oil type air cleaner. This is mounted on a bracket to the left of the rear cylinder. A heavy screen in the air intake cap prevents any large particles of dirt from entering the cleaner. The air then passes to the oil cup, where it goes through a bath of oil. As the air rises to the intake manifold, it passes through a series of oil-bathed screens, and any fine dust is removed. As the oil from the screens works back down, it carries the dirt with it, and the dirt, or any foreign matter, settles in the oil cup. This oil cup must be cleaned regularly and refilled with new oil.

6. EXHAUST SYSTEM

Section B-4-*b*, "Exhaust Connections" covers the description and installation of this system.

7. COOLING SYSTEM

a. *Operation* — The cooling water is circulated through the engine block, cylinder head and radiator by the circulating pump, which is of the positive centrifugal type. Two thermostats of the bypass type are set in the cast iron housing bolted to the front of the cylinder head. These thermostats control the temperature of the cooling water.

b. *Water Circulation* — The path of the water, when the engine is cold, is from the radiator bottom up through the pump, through the engine block to the cylinder head, out into the thermostat assembly and then bypassed back to the pump. Any water that may escape into the radiator is made up from the supply at the bottom of the radiator. This limited circulation, during the warm-up period, insures quick arrival of the engine at an efficient operating temperature and prevents the formation of steam pockets.

c. *Thermostat Operating Temperatures*—The thermostats will start to open, due to rise in the water temperature, at 165°F. The temperature of the water controls the amount of opening of the thermostats, which control the amount of water recirculated through the pump, and also the amount of water added from the radiator. The thermostats are wide open at 190°F. Under this condition no water is recirculated through the pump, and the flow is from the pump to cylinder head, through the radiator, and back to the pump.

d. *Cooling of the Valves*—The engine of the unit has a special cooling feature in that water rising from the cylinder block is directed by tubes to the areas between the valve stems, carrying heat away from the metal surrounding the valve stem guides and seats, thereby lowering valve temperatures.

e. *Fan for Cooling*—Cooling air is forced through the radiator by an outward draft fan. This fan is driven by a double "V" belt, the tension of which can be adjusted by the movement of an idler pulley.

8. FUEL OIL SYSTEM

a. *General* — The fuel oil system consists of the following: (figs. 10 and 12)

(1) Supply pump, located forward, low down on the right side of the engine.

(2) Supply pump strainer, adjacent to supply pump.

(3) Injection pump, located on left side of engine crankcase.

(4) Transfer pump, bolted to the housing of the injection pump (fig. 10).

(5) Scavenging pump, which is part of the transfer pump.

(6) Intermediate or "day" tank located directly beneath the injection pump.

(7) Fuel oil filter, located on the left side of the engine. (This is the forward one of the three filters.)

(8) Six spraying nozzles, one for each cylinder, located on the side of the cylinder head.

(9) Necessary piping, etc.

A storage tank forms part of the system, but is not part of the equipment supplied.

b. *Operation*—Fuel oil is drawn from the storage tank, through the strainer, by the supply pump which delivers it to the intermediate tank. The transfer pump draws the oil from this tank and pumps it through the fuel oil filter, under pressure, to the injection pump. The injection pump delivers the correct amount of fuel to the respective spraying nozzles at the proper pressure and at the proper time. All leakage, or excess fuel oil from the injection pump, or any oil bypassed by the transfer pump, is returned to the line by the scavenging pump.

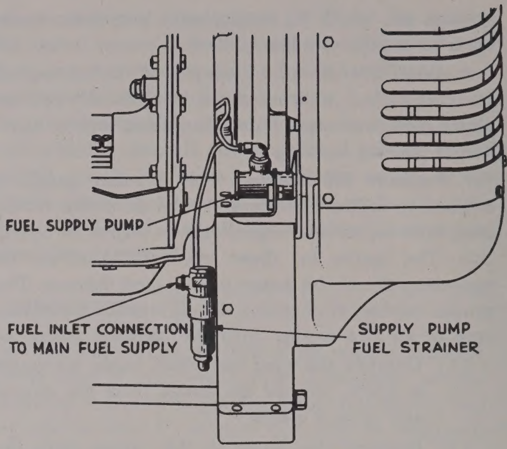
FUEL SUPPLY PUMP
FUEL INLET CONNECTION TO MAIN FUEL SUPPLY
SUPPLY PUMP FUEL STRAINER

FIG. 12 — SUPPLY PUMP AND STRAINER

9. FUEL OIL SPECIFICATIONS

Specific Gravity (minimum)	24°B.
Viscosity (Saybolt Universal) (at 100°F.)	Minimum 35 seconds Maximum 100 seconds
Sulphur (by weight)	Maximum 1.5 seconds
Conradson Carbon	Maximum 1%
Flash Point	Minimum 150°F., or legal minimum
Water and Sediment (by volume)	Maximum .5%
Four Point	Must be lower than minimum temperature at which fuel oil is to be used.
Distillation Test	10% at 460°F. maximum 95% at 675°F. maximum End point 700°F. maximum

NOTE: *Do not use a lower grade of fuel oil than specified above.*

10. GOVERNOR

a. *Purpose* — The governor serves as a means of pre-setting and maintaining, within close regulation, any desired engine speed within the idling and maximum range of the engine, irrespective of load variations. The governor on the engine is adjusted to give an engine speed of 1200 RPM. It is carefully set at the plant of the supplier and sealed. It should not be altered in any way.

b. ***Description***—The governor, which is of the fly-weight type, is a fully enclosed unit, rigidly mounted to the back end of the injection pump housing. The governor shaft is gear-driven from the injection pump camshaft at a higher speed than the pump camshaft. Any variation in the centrifugal force exerted by the governor weights alters the amount of fuel so that an engine speed is maintained of 1200 RPM with a 3% variation.

c. ***Operation***—When the engine is operating, either under load or at no load, the centrifugal force of the fly-weights is balanced by a governor spring. Any change in the position of the fly-weights, due to fluctuations in the engine speed, is transmitted to the injection pump plungers through a yoke or fork, the movement of which operates a toothed rack which engages toothed sections on the plungers, causing them to be rotated. Any rotation of these plungers increases or decreases the amount of fuel oil delivered to the engine, thus controlling its speed to meet the load conditions.

11. SAFETY DEVICES

a. ***General*** — The safety device, fig. 4, which is a Fulton-Sylphon #530, provides protection by shutting the engine down in event of high cooling water temperature or low lubricating oil pressure. It is located forward on the left-hand side of the engine. In the fuel oil circulating system, it is immediately ahead of the injection pump.

b. ***Description***—The mechanism of the safety unit is enclosed in a housing. It has a removable cover held in place by four fastening screws, two of which are drilled for a seal wire and the unit is sealed. It is carefully set at the plant of the supplier and should require no adjustment. Attached to the bottom of this housing is a three-way valve. The fuel supply line enters the lower part of this valve body, which is tapped for ½" I.P.S. The outlet to the injection pump is on one side of the valve body and the vent is opposite this. These connections are plainly marked on the valve body. Both of these outlets are tapped for ½" I.P.S. There are two separate floating poppets in this valve body and these are extremely closely guided to assure tight closure of these valves. The lubricating oil pressure release and the cooling water temperature release are in the housing above the valve body. These are spring loaded and held in the normal engine operating position by a simple trigger arrangement. These releases are set for 15 pounds lubricating oil pressure and 205°F. water temperature, respectively. If either of these releases are caused to operate, they trip the trigger, releasing a spring loaded lever which operates the poppet valves, closing off the fuel supply to the injection pump immediately and at the same instant opening the vent valve which drains the fuel oil, between the safety unit and the injection pump, back into the fuel supply tank. The draining of this oil away from the injection pump while the supply is cut off results in a quick stopping of the engine. If the safety device is caused to operate, it will be necessary to reset the trigger or latch. An external lever is provided for this purpose. This trigger will not engage its catch unless the condition that released it no longer exists. In event of failure or damage to either the pressure or the thermostatic element, the safety control will operate to stop the engine. The entire safety device is vibration proof and requires no oiling. Adjusting nuts are provided on both the safety controls but, as noted above, the adjustment of these releases is carefully set and should not be altered in any way. It is necessary to set the trigger on the safety device each time the engine is started as when the engine is stopped the lubricating oil pressure drops to zero which causes the safety device to operate.

12. COLD WEATHER OPERATION

a. ***Precautions*** — If the unit is to be used in temperatures of 32°F., (0°C.) or lower observe the following precautions:

(1) Use only a high test gasoline for starting and keep the supply in a closed container so the more volatile portion does not evaporate. Fill the tank at the end of a day's run in order to prevent moisture from collecting in the tank.

(2) Fill the fuel oil tank for same reason as above.

(3) Be sure the correct grade of lubricating oil is used in the crankcase and air cleaner, magneto and impulse coupling.

(4) If an anti-freeze solution, as listed in the following table, is not used, all water must be drained from the system each time the engine is shut down. This is done by opening the crankcase water drain cock, located near the fuel oil filters, and removing the radiator drain plug.

QUANTITY OF ANTI-FREEZE	DISTILLED GLYCERINE FREEZING POINT			ETHYLENE GLYCOL FREEZING POINT		
	°C	°F	SPECIFIC GRAVITY	°C	°F	SPECIFIC GRAVITY
0	0	32	1.000	0	32	1.000
2 gals. 2½ qts.	–2	29	1.029	–3	26	1.016
5 gals. 1 qt.	–6	21	1.057	–9	16	1.031
7 gals. 3½ qts.	–11	12	1.085	–16	3	1.045
10 gals. 2 qts.	–18	0	1.112	–24	–11	1.058
13 gals. 0 qt.	–26	–15	1.140	–35	–31	1.070

C13 — TYPICAL TEST DATA

INTERNATIONAL DIESEL ELECTRIC CO.

U. S. Army - Signal Corps Contract W-2124-sc-3637 - Order No. 1628-Phila-43

Date May 10 1943 Serial No. 129

Engine No. 3356 Alternator No. 5840137 Fuel Pump No. H13566

WITNESS TEST REPORT

Signal Corps Specification No. 171-209-A. Section F-2a

Workmanship & Materials: O.K.	Noise: O.K.

Vibration: O.K.	Commutation: O.K.	Lubrication: O.K.

Section F-2c

(2) Voltage Regulation (0.8 p.f.)

KW Load		Voltage			% Regulation		Time to
Start	Finish	Start	Finish	Transient	Steady	Transient	Steady
0	25	252	246	241	2.44	4.36	1 sec.
25	50	246	241	236	2.08	4.07	2 sec.
50	25	241	248	254	2.90	4.15	1 sec.
25	0	248	253	261	2.02	5.24	1.5 sec.
							sec.

(3) Heat Run (Full Load 150 Amps. 240 V. for 4 hours at normal amb.)

Time	Alternator						Exc. Amp.	Lube Oil Press	Temperature in deg. C					°F	°C
	Volts	Amp.	KW	Calculated		Freq.			Amb.	Alt. Rtr.	Alt. Sta.	Alt. Frm.	Exc. Frame	Lube Oil	Jkt Water
				KVA	p.f.										
8.00	240	150	50	62.4	0.80	60	21	OK	19		19	19	19	--	70
8.30	240	150	50	62.4	0.80	60	21	OK	22		34	36	32	140	76
9.00	240	150	50	62.4	0.80	60	21	OK	24		37	41	36	152	76
9.30	240	150	50	62.4	0.80	60	21	OK	24		38	43	37	160	76
10.00	240	150	50	62.4	0.80	60	21	OK	24		40	44	38	160	80
10.30	240	150	50	62.4	0.80	60	21	OK	22		39	44	37	160	80
11.00	240	150	50	62.4	0.80	60	21	OK	23		39	45	38	160	80
11.30	240	150	50	62.4	0.80	60	21	OK	23		39	45	39	160	80
12.00	240	150	50	62.4	0.80	60	21	OK	23	40	41	45	38	160	80

(5) Speed Regulation.- Freq. Full Load: 60 No Load: 22 % Reg: 3.33

(6) Starting Test: O.K.

Synchr. Lights: O.K.	Circuit Breaker: O.K.
Oil Pressure Stop: O.K.	Insulation Test: O.K.

General Remarks:

Test Man: Bernard Cappel

Inspector: D. Mangan

D. MAINTENANCE AND REPAIR

1. IGNITION

a. *Description*—The ignition system used, as previously explained for starting only, consists of: a magneto, a distributor, wiring and a spark plug for each cylinder. In gasoline engines of the conventional type, sudden failure during operation—assuming that no mechanical breakage is evident—is usually due to lack of fuel caused by a stoppage in the fuel supply line or an empty gas tank, or to a breakdown in the ignition system. In the case of an engine of the Diesel type which is under discussion, any such failure in ignition system would be confined to the starting period as the ignition system is inactive during the oil operation of the motor.

b. *Failure to Start*—If the motor fails to start, proceed as follows:

(1) When the electric starter button is pushed in and engine does not turn over at all, check to be sure compression release lever is moved as far in a clockwise direction as possible. Make sure this movement is complete. If this is in correct position and engine does not turn over, it is due to a binding in the mechanical parts of the engine, or a "dead" starting storage battery or loose battery connections. Also the electric starter switch contacts may be corroded. This is likely to be so if the unit is located near salt water and has been out of service for some time.

(2) Try turning the engine over with the hand crank.

(3) Assuming that the mechanical features have all been found satisfactory and the engine turns freely, check the storage battery. This is done by the use of a hydrometer. The specific gravity of the battery fluid in a fully charged battery should be between 1.270 and 1.290. If the specific gravity is low, have the battery charged or replaced: NOTE: It is most important to always have the battery in condition to start the engine on a moment's notice. The hydrometers used for battery testing are usually marked "Full Charge," "Half Charge" or "Discharged," in addition to the actual specific gravity figures. If everything so far has been satisfactory then proceed as follows:

(4) Disconnect a wire from any spark plug and hold or support the terminal end about 3/16" *away* from any part of the motor, being careful to keep it away from the hands. Press the starter switch. This should result in a bright spark jumping across the gap between the terminal on the end of the wire and the metal of the engine. CAUTION: *This operation should not be performed near the gasoline tank or the carburetor.* If a bright spark is obtained, it may be assumed that the ignition system is in good working order. This test may be repeated on each spark plug wire.

(5) Spark plugs should be taken out and cleaned with a stiff brush or sand-blasted if this equipment is available. The spark gap should be checked with the gap gauge supplied in the tool kit. If a gauge is not available, a U.S. ten cent piece or comparable coin in thickness can be satisfactorily used as a gauge. Make what adjustment of the gap is necessary.

The test listed under #4 above may be made by removing the plugs, attaching the plug wires to them and laying the plugs on the cylinder head so that only the threaded section touches the metal of the motor. The sparking of the plugs can then be seen. CAUTION: *Do not place the plugs for this test directly over the spark plug holes in the cylinder heads as there may be unexploded gas in the cylinder which might light and blow out of the hole, possibly causing injury to the operator or other damage.* If the plugs cannot be satisfactorily cleaned, or if the porcelain is cracked or broken, replace them with new plugs.

(6) If no spark or a poor spark occurs during the above tests, proceed as follows:

(a) Examine wire for breaks or connections that have become loosened or broken. Replace broken wires and tighten loose connections. Check battery connections carefully.

(b) Examine the ignition points in the breaker mechanism. If slightly pitted or worn, renew the surfaces with a small fine file or oil stone. (These are really not points, although referred to in this way, but are flat round discs about 3/32 inch in diameter.) If the points are badly burned, they should be replaced. This means the entire point assembly must be replaced. This consists basically of a flat spring, near one end of which on the flat surface is the actual contact point referred to as a small disc of metal. If this burning of the points occurs rapidly, it is due to the failure of the small cylindrical condenser in the distributor (see section D-1-*f*).

c. *Distributor* — To remove the distributor cap, push the distributor cap springs out of cap recesses and pull off the cap.

The six spark plug cables lead from the distributor to the plugs. These cables are marked with numbers corresponding to the cylinders, number one cylinder being forward or nearest the radiator. The position of the number one cable is marked on the distributor cap and the positions of the other cables are located from this one. Facing the radiator and proceeding in a clockwise direction, the order is that of the firing order of the engine, viz., 1-5-3-6-2-4.

d. *Distributor Points*—The magneto turns clockwise when viewed from the front of the engine. The distributor points may get smeared or "spotted". This is due to the heat generated by the current flow, and as the magneto under discussion is designed so that the polarity of the sparks which occur alternates with every other point, any such spotting will occur on every other point. Also, the magneto is designed for a very short spark range and therefore it is timed so that no spark will occur as the brush leaves the distributor points. On account of this, any spotting should occur on the leading edge of the points. If the spots occur on the following edge of the points, the timing of the magneto should be slightly advanced. See Section D-3. This condition should not exist, as the proper adjustment is carefully set at the plant of the supplier. If any carbon deposit is evident in the "brush track", this can be readily cleaned with a soft rubber eraser. *Do not use sandpaper or any abrasive.*

e. *Breaker Point Adjustment*—As noted under D-1-b, the points on the breaker arm should be resurfaced, if necessary, with a small, fine file or oil stone. The point on the arm should be filed flat, but the other or stationary point should be slightly rounded. In any event, be sure that there are no burrs or projections around the edges or rims of the points, as a condition of this kind would cause a slower break and a weak spark. It is important that the separating of these two points be as rapid and "clean" as possible. The point opening, or maximum separation of these points, should be .020 inches (fig. 13), which occurs when the rubbing block is on the high point of the cam. A feeler gauge of this thickness is supplied with each power unit. The high point of the cam can be turned, so that it will raise the breaker arm, by slowly cranking the engine until the impulse coupling trips. Then turn the engine backward, by grasping the fan blades, just enough so that the high point of the cam will raise the breaker. To adjust the gap, loosen the screw in the stationary point and move the point in the necessary direction so that the gauge will slip snugly in the opening. After adjustment, be sure to tighten this screw. Before reassembling, clean all parts to remove *all* grease and any dirt. Then grease with magneto grease as indicated in fig. 13.

f. *Condenser Testing*—The condenser, located in the magneto body, is mounted vertically and can be easily removed by first removing the magnet and the frame cover. CAUTION: Note the position of the magnet before removal. It must be replaced in the exact position. A monogram of the letters IHC is stamped on the side of the magnet away from the engine. If this mark does not appear, mark the magnet. If it is reinstalled in the wrong way, the polarity of the magneto will be reversed. Disconnect the primary wire from the condenser terminal. This is the only wire connection to the condenser, the case being the other terminal. Removal of the clamp releases the condenser. The condenser may be tested for a short circuit by using a 110 or 220 volt test lamp in series with the corresponding voltage line. Touch one wire to the terminal of the condenser and the other to the condenser case. If it is shorted, the lamp will light. If the lamp does not light, or in other words, if the condenser is not short-circuited, then remove the test wire from the terminal and slide the other wire along the case or housing, bringing it close to the terminal while keeping it in contact with the case. A snappy flash should result. If direct current is used for the test, this flash will occur every time on a good condenser. If alternating current is used, the test should be repeated a number of times, because in charging the condenser with A.C. the contact of the test wire has to be broken at just the right time or the charge will be partially or entirely removed by the reversal of the current. The 12 volt storage battery in series with a 12 volt lamp may be used for this test but it is better to use 110 or 220 volts, for the short circuit test.

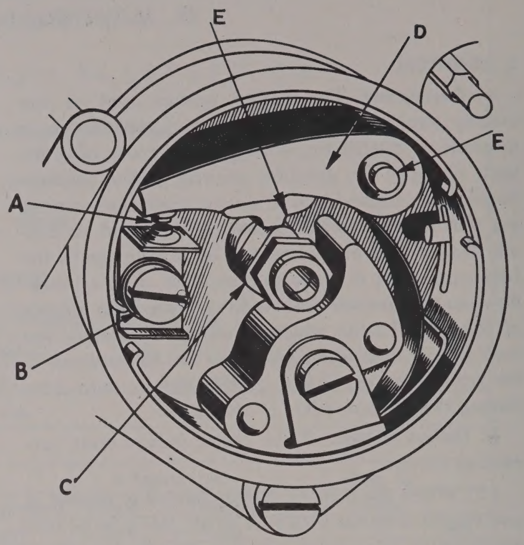

FIG. 13 — BREAKER ASSEMBLY

A—Breaker Points
B—Breaker Point Adjusting Screw
C—Cam
D—Breaker Arm
E—Grease Points

2. IMPULSE COUPLING

a. ***General***—The purpose of the impulse coupling of the magneto is to produce high speed of the magneto rotor during the electric or hand cranking period of starting when the magneto would not be rotated rapidly enough to produce the necessary voltage. This higher speed of the rotor is obtained by the compression of a spring, which is suddenly released. The releasing of this spring supplies a "kick" to the rotor, thus producing the desired voltage. The operation of the impulse coupling is completely automatic and requires no adjustment or manual engaging or disengaging. The throw out speed of the coupling is about 135 RPM.

b. ***Impulse Coupling Spring***—

(1) *Description*—It may be necessary to replace the drive spring, so a brief description of its function is advisable. The principal parts of the coupling are a cam member, which is locked to the magneto drive shaft on the engine and a magneto member with the drive spring and engaging pawl, which is keyed to the magneto rotor shaft driving end. The cam member and the magneto member are connected by a spiral drive.

(2) *Operation*—As the cam member and the magneto member rotate slowly, the pawl, which pivots on a pawl pin, engages in the upper ratchet slot in the magneto member and prevents the magneto member from turning. The cam member continues to turn and winds up the drive spring. The pawl is then tripped from the ratchet slot by the cam member. The spiral spring unwinds, causing the magneto rotor to revolve rapidly and thus generate the necessary voltage to produce the required spark.

(3) *Replacement* — To replace the spring, the magneto will have to be removed from the engine. The oil lubricating cup position on the housing is such that by inserting a small finishing nail through this opening, the pawl latch may be lifted, thus releasing the pawl, which is necessary to be sure that the drive spring is not under tension. The housing may now be taken off. The coupling member will have to be removed with a puller. Starting the puller in the threads, then lock the member with the pawl and screw down on the puller. To separate the cam member from the magneto member, pull it outward until the lugs are clear and let it unwind about one-half turn and remove it. The drive spring can easily be pried out with a screwdriver NOTE: *Be sure and note carefully the position of this spring and the direction of its coil.* When assembling the coupling, be sure that the hub of the magneto member is clean and well oiled, and if the latch spring is rusty replace it. When reinstalling the magneto, it will be necessary to retime it. See Section D-3.

3. MAGNETO TIMING

a. ***Distributor Timing*** — The distributor gears are marked with a line. If they have been thrown out of mesh for any reason, line up these marks in the two gears.

b. ***Timing the Magneto*** — Be sure the breaker points are clean and adjusted as outlined in section D-1-*d*. Replace the breaker housing cover, move the lever end up as high as it will go and remove this cover. In this position the magneto will deliver no spark. Secure the magneto loosely in place on the bracket. *Do not use base screws longer than the originals as they will damage the magneto.* Place the No. 1 piston of the engine on firing dead center. The compression stroke can be determined by removing the No. 1 spark plug, placing the thumb over the opening and having an assistant crank the engine until an outward pressure is felt. Then line up the "DC" mark in the water pump drive with the "M" mark. Be sure the impulse coupling is released as described in section D-2-*b*. Take off the distributor block and grasp the magneto half of the adjustment coupling and rotate it clockwise (as viewed from the coupling end) until the breaker points just start to open. Without changing this position, replace the magneto drive coupling cap screws and shims. This coupling is so made that only two holes line up exactly opposite each other. The cap screws must not be forced or the timing will be incorrect. When this is completed, the magneto is properly timed. Tighten the magneto down in place, replace the distributor block, breaker housing cover and spark plug cables.

4. SPARK PLUGS

a. ***General***—The spark plugs are S.A.E. ⅞″—18 thread. The gap is .035 to .040 inches, and a feeler gauge is supplied for checking this.

b. ***Adjustment and Cleaning***—In checking the gap of the spark plugs, do not be misled by a gap which may appear to be .035 inch with the gauge. A careful visual examination is also necessary in order to see that the electrodes have not been burned off at an angle. Turbulence in the combustion chamber blows the spark away from the electrodes so that the jump is not direct. This "curved" jump burns the electrodes at an angle. They should be filed parallel and then adjusted with the feeler gauge. As previously noted, plugs should be cleaned with a stiff brush or sand-blasted if this equipment is available. Plugs that do not clean up readily or that have cracked porcelains should be replaced.

5. COOLING SYSTEM

a. ***Adding Water***—Frequent examination should be made to see that the water system is full. Evaporation of cooling water will, of course, be more rapid if the unit is operated in tropical climates or in an improperly ventilated location than it will be under favorable cooling conditions. Add the amount of water necessary to bring the level up to the radiator filler cap.

Caution: NEVER ADD COLD WATER TO A HOT ENGINE OR HOT WATER TO A COLD ENGINE.

Neglect of the above caution will very likely result in cracked cylinders or water jacket. However, under certain operating conditions when it is imperative that an operating unit be not shut down and it is evident that only a small quantity of water, say two or three gallons, is needed, water may be added *very slowly* so that the added water will not cool the system appreciably.

b. *Thermostats*—The two thermostats are located in the thermostat housing, between the top of the first cylinder and the radiator. The action and purpose of these devices, as described in section C-7, is to bring the temperature of the engine up to an efficient operating point as rapidly as possible. The thermostats start to open at 165°F. and are wide open at 190°F. When the thermostats are closed, no water is circulated through the radiator, the water being bypassed directly back to the circulating pump. As the thermostats start and continue to open, water is slowly added to the warm water which was being circulated through the system with the exception of the radiator. *No adjustment of the thermostats is possible.* However, after long service the thermostats may stick, due to corrosion or other causes, in which case they should be removed from the engine and cleaned.

c. *Removing Thermostats* — To remove the thermostats, for cleaning or replacing, it is only necessary to disconnect the water hose leading from the thermostat housing to the top of the radiator and unbolt the housing from the flange on the cylinder block. In replacing the assembly, be sure and install the gasket between the housing and the flange on the engine. If this gasket is not in good condition, replace it.

d. *Testing Thermostats*—If these are believed to be working unsatisfactorily, they may be checked for point of opening by placing them in a pan of water, with a thermometer, heating the water to the desired temperature. Movement of the valves under these conditions can readily be seen.

e. *Water Pump Packing*—The water pump is located between the fan assembly and the radiator. The fan assembly is mounted on a sleeve which is press-fitted into the water pump body. The impeller of the pump is driven by a full floating shaft inside the sleeve, thus relieving the shaft assembly of all loads from the fan belt and assuring a long life of the packing. Due to wear, after considerable service, the pump may leak. When this occurs, tighten the packing nut shown in fig. 14, just enough to stop the leaking. It may be necessary to remove the special fan guard in order to reach this nut.

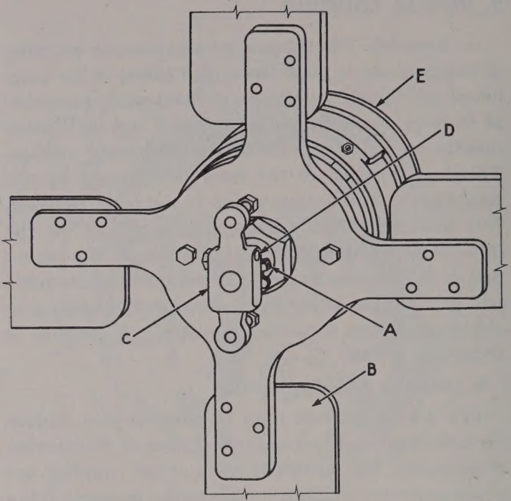

FIG. 14

WATER PUMP DRIVE AND PACKING NUT

A—Packing Nut **B—Fan**
C—Pump Driver **D—Driver Pin**
E—Fan Belt Pulley

Caution: EXCESSIVE TIGHTENING OF THIS NUT MAY CAUSE A BREAKAGE IN THE ASSEMBLY.

After all possible adjustment is taken up on the packing nut, which will be evident from the packing nut coming in contact with the pump housing, it will be necessary to add more packing, or preferably, to remove the old and install new packing. This is obtainable in graphited split segments or rings about ¼ inch. This packing sometimes comes in the form of a cotton rope, graphited. This is a satisfactory packing. It is used by wrapping it around the shaft for as many times as is possible and still be able to screw in the packing nut. Also, in an emergency, cotton string saturated in oil or grease may be used.

6. LUBRICATING OIL SYSTEM

a. *Oil Level*—Daily, or every 10 hours of operation, check the oil lever in the crankcase with the bayonet type oil gauge located between the injection pump and the day tank. (See fig. 10.) The proper method of using this gauge is described in section C-4. This section also covers the correct grade of oil to use under varying temperature conditions. The oil filler is located forward and on the left side of the engine under the gasoline tank.

CAUTION: KEEP THE SUPPLY OF LUBRICATING OIL ABSOLUTELY CLEAN AND FREE FROM DUST, ETC. ALWAYS USE CLEAN CONTAINERS AND WIPE THE FILLING SLEEVE CLEAN BEFORE POURING IN OIL.

7. OIL PRESSURE

a. *Oil Pressure Gauge*—If the indicator of the oil pressure gauge on the instrument panel drops in the red section of the dial or if, in case of a gauge graduated in pounds, the pressure drops below 25 pounds at full engine speed, check to see if sufficient oil is in the crankcase. If the addition of any necessary new oil does not raise the pressure, check to see that there are no oil leaks. Worn bearings will cause a drop in oil pressure. If the screen in the floating oil intake in the crankcase becomes clogged the oil pressure will drop.

b. *Oil Pressure Valve*—The pressure necessary to circulate the oil through the engine is controlled by a plunger type regulator valve in the oil pump body in the crankcase. The plunger of this valve works against a spring which is adjusted at the plant of the supplier and should not be altered in any way. The valve is regulated to deliver oil at 60 pounds pressure.

c. *Oil Pressure Valve Spring*—If for any reason the oil circulating pump is removed from the crankcase, the pressure regulating valve spring may be checked by removing the valve from the pump body. The free length of this spring when in good condition should be 3-3/32 inches, and under a compression load of 47.6 pounds, it should be 2-3/32 inches. As valve springs take a set after continued use, it is best to test this spring under the load noted, and if it does not meet the required figure of 2-3/32 inches, it should be replaced. When reinstalling this spring or replacing with a new one, be sure the valve slides freely and the spring does not cock the valve in the bore, thus causing it to seat improperly.

8. OIL IN AIR CLEANER

a. *Changing the Oil*—The oil in the air cleaner (fig. 2) should be changed daily or every 10 hours of operation. The bottom section or oil container must be removed and washed out with kerosene. The filter screens must also be thoroughly cleaned with kerosene. They are easily removed after taking off the ring clamp that holds them in place. The air intake cap and screen and the air intake pipe should be cleaned. Fill the oil container to the indicated mark, using the same grade of oil as is used in the crankcase. Use care in reassembling the oil container and see that all joints are air tight to prevent the entrance of dirt particles. A loss of engine power will result if the air cleaner does not function properly.

9. MAGNETO OIL

a. *Impulse Coupling and Distributor*—The impulse coupling should be liberally oiled with very light oil similar to sewing machine oil, weekly or after 60 hours of operation. Do not use engine oil. The distributor should be oiled after 500 hours of operation with a very light oil. The distributor bearing oil cup is located on the top of the magneto near the magnet. The rotor bearings should be oiled after approximately 1000 hours of operation. There are two cups for this purpose, one located on the side of the magneto near the breaker housing and the other on the impulse coupling end of the magneto. (See fig. 15.)

10. FAN BEARING

a. *Lubrication*—Weekly, or after 60 hours of operation, the fan bearing should be greased with a pressure gun. The fitting for this is located between the first cylinder and the fan.

11. CRANKCASE OIL

a. *Changing the Oil*—Every 100 hours of operation, drain the oil from the crankcase while the oil is hot, by removing one of the drain plugs in the bottom of the crankcase. Refill with new oil. Twenty-two quarts will be required. If the temperature where the engine is being operated changes appreciably, the oil will have to be changed to meet the new condition. The grades of oil for various operating temperatures are specified in section C-4-d.

12. OIL FILTERS

a. *Purpose*— The lubricating oil filters, two in number, are the rear two of the group of three located on the triple bracket on the left side of the engine. The forward unit of the three is a fuel oil filter.

In the normal course of engine operation, minute particles of abrasive material accumulate in the crankcase of the engine and also the oil undergoes changes which may produce sludge, acids, gums, etc. It is the purpose of the oil filters to separate and remove these substances and any dlirt in the oil to prevent them from being circulated in the engine.

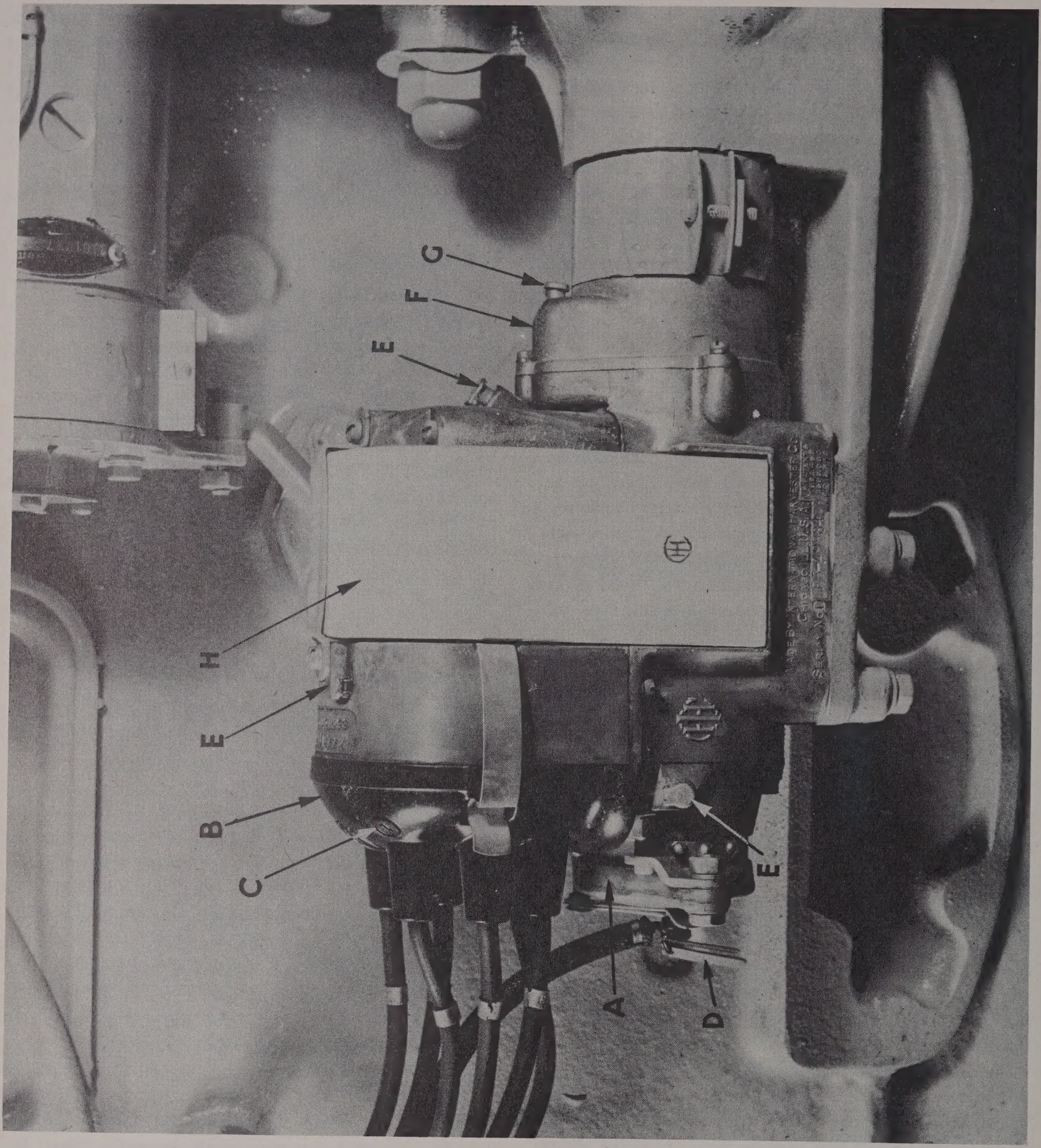

FIG. 15 — MAGNETO AND IMPULSE COUPLING

A—Breaker Housing
B—Distributor Cap
C—Location Mark for No. 1 Cylinder Spark Plug Lead
D—Breaker Point and Spark Plug Gap Gages
E—Magneto Oil Cups
F—Impulse Coupling
G—Impulse Coupling Oil Cup
H—Magneto Magnet

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This is accomplished by the filtering element housed in the filter shells. These elements cannot be cleaned. Oil cleaned by the filters is returned to the crankcase.

b. *Replacing Filter Elements*—After 100 hours of operation, or whenever the crankcase oil is changed, new filter elements should be installed in the shells. To replace the elements, loosen the bar nuts on the top of the shells and remove the shell caps. Take out and discard the old elements. Remove the drain plugs at the bottom of the shells and allow oil to drain out. If it is evident from the condition of the elements or the drained oil that considerable dirt and sludge has been collected, rinse out the shells with kerosene. Install the new elements and replace the caps, turning the bar nuts down by hand only.

13. FUEL OIL SYSTEM

a. *Component Parts*—The various parts and pieces of equipment that make up the fuel oil system are listed in section C-8-a.

b. *Injection Pump*—It is not recommended that any repair be attempted on the fuel injection pump. Always check first for possible engine troubles before attempting any alteration of this pump. The fuel injection pump and also the nozzles should not get out of order under normal operating conditions provided the fuel oil has been effectively filtered, and dust, etc., has not been permitted to enter the equipment and frequent use of the water drains has been made. Absolute cleanliness is necessary for trouble free operation of the injection equipment. Never break any connections or remove the pump or any part of the system without first washing clean with fuel oil and as soon as any connections are broken cover the openings carefully with clean cloths tied in place.

c. *Description of Injection Pump* — The injection pump, fig. 10, is a completely enclosed unit having a camshaft, gear driven by the crankshaft, in the lower half of the housing which operates, through roller tappet assemblies, six constant stroke, lapped-plunger metering pumps—one for each engine cylinder located in the upper half. These metering pumps deliver the fuel oil to the respective cylinders through high pressure piping and the injection nozzles. The camshaft also operates the transfer pump which delivers fuel oil under pressure from the day tank to the injection pump. This pump is located on the side of the injection pump housing. The governor, which is located on the right hand end of the injection pump housing, is driven through gears, by the injection pump camshaft.

d. *Operation of the Injection Pump*—After passing through the fuel oil filter, the fuel oil is forced into the sump of the injection pump under pressure exerted by the transfer pump. The sump, which is completely filled with oil, extends the full length of the pump. At one end of the sump is the overflow valve which maintains the oil within the sump at approximately a constant pressure. Each metering pump is composed of two parts — a firmly fastened barrel and the plunger. Two radial opposite ports are cut in the barrel, one being the inlet and the other the overflow, both leading to the sump. A vertical groove and an intercepting helix are cut on the plungers. Considering one metering pump only, as soon as the upper edge of the plunger, on its downward stroke, opens the two ports, the fuel oil, which it must be remembered is supplied under pressure, rushes into the barrel from the sump and completely fills it. During the first part of the upward stroke, some of the oil is returned to the sump, through the ports, until these are completely closed by the plunger. The oil, trapped above the plungers at this point, is put under high pressure by the plungers continued upward movement, until a spring loaded valve, located in the top of the barrel assembly, is forced open and the fuel is delivered through individual piping to the respective spraying nozzles by which it is discharged into the combustion chamber of the engine. The plunger can be rotated in the barrel. This is accomplished by a sleeve which is slipped over the barrel, the sleeve being provided with a toothed segment at its upper end and provision made at its lower end to engage the plunger pump rod. A control rod is provided, which has a toothed section which meshes with the teeth on the sleeve. This control rod is operated by the governor or may be manually operated. In either case the movement of this rod causes the plungers to be rotated, thus altering the relative position of the helix cut groove on the plunger and the ports to the sump. This, in turn, regulates the amount of fuel oil trapped by the plungers as unwanted or unnecessary oil is bypassed by the helix groove back to the sump. As the speed of the engine is controlled by the amount of fuel oil delivered to the cylinders, this arrangement results in the control of the engine. The fuel oil is, of course, mixed in the cylinders, with air taken in through the Diesel section of the intake manifold.

e. *Removing the Injection Pump*—If it is necessary to remove the injection pump for replacement, turn off the fuel supply underneath the tank immediately below the pump, disconnect the tubing at the pump and at the nozzles and cap all openings to prevent entrance of dirt. Pry the leather boot from the coupling and remove the supply lines, the control rod and the four cap screws from the pump bracket. Place the coupling on the pump drive. This fits only in one position. Then fasten the bracket to the new pump.

Set the engine on the "SI" (Start of Injection) mark on the water pump drive. CAUTION: BE SURE TO REMOVE THE DISTRIBUTOR CAP OF THE MAGNETO TO PREVENT STARTING OF THE ENGINE. Set the "SI" mark on the pump flange in line with the mark on the face plate of the pump. Lift the pump into position and make all connections. Move the lever on the serrations of the control rod so that full travel of the hand throttle lever is obtained. Start the engine and bleed all air from the nozzles and the fuel oil filter.

f. *Timing the Injection Pump* — While the engine will operate satisfactorily when the injection pump is installed as described in the foregoing section, provision is made to secure timing for the most efficient operation. The pump drive has a timing adjustment between the drive flange and the timing couplings where the point of injection can be advanced or retarded from the center position a maximum of 7 degrees on the pump, which is equivalent to 14 degrees rotation of the crankshaft. (See fig. 16.) After loosening the cap screws the adjuster may be moved. The best position for this adjustment is where the engine speed is such that the governor holds the engine down to 1200 R.P.M. under a given load, and the engine operates smoothly and the exhaust is cleanest. When this point is obtained be sure and tighten the cap screws.

g. *Injection Nozzles* — The injection nozzles, one for each cylinder, spray the fuel oil received under high pressure from each of the six metering pumps into the respective cylinders. The high pressure (about 700 pounds per square inch) at which the oil is forced through the nozzles, results in an atomizing of the oil. If any cylinder seems to fire too noisily it usually is an indication that the nozzle valve is leaking badly, thus permitting the oil to enter the cylinder at the wrong time for efficient combustion. This may be due to carbon or dirt in the valve. It will be necessary to remove the nozzle to clean it, but before doing this, wash the exterior thoroughly with clean fuel oil. Remove the assembly by taking out the two holding bolts. (See fig. 17.) Before the nozzle is disassembled for cleaning by unscrewing the nozzle fitting from the nozzle body, check the length of the valve spring so that the spring can be reassembled to the original working position. The pressure of this spring when correctly assembled should be 34 to 35 pounds. Clean the valve and seat with clean fuel oil. CAUTION: USE NO ABRASIVE AND DO NOT APPLY ANY METAL DEVICE TO CLEAN THE VALVE SEAT OR OPEN THE SPRAYING ORIFICE. In reassembling the nozzle be sure that the dust seals and the metal gasket are in good condition. If there is any doubt as to their serviceability, replace them.

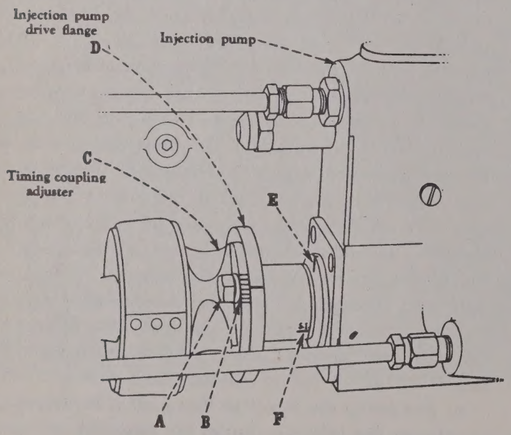

FIG. 16 — TIMING INJECTION PUMP

A—Cap Screw **C—Coupling Adjuster**
B—Slot in Flange **D—Drive Flange**
E—Start of Injection Mark on Pump Housing
F—Start of Injection Mark on Drive Flange

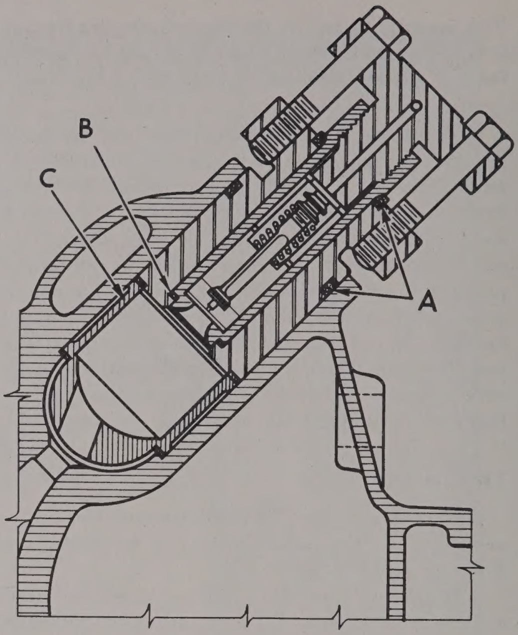

FIG. 17 — INJECTION NOZZLE SECTION

A—Dust Seal **B—Copper Gasket**
C—Pre-Cup

The nozzle body retainer can be removed for the replacement of the pre-cups. There are gaskets on the top and bottom of the spacers. When putting spacer or pre-cup into the cylinder head be sure the side marked "UP" is toward the center of the engine.

h. *Transfer or Primary Pump* — The primary or transfer pump is located on the side of the injection pump housing. (See fig. 10.) Its purpose is to pump the fuel oil from the supply or day tank and deliver it under pressure to the injection pump. The transfer pump is of the variable stroke, self regulating, plunger type, the stroke being limited by the pressure in the delivery tubing to the injection pump sump and by a spring loaded overflow valve, located in the top of the injection pump, which returns surplus oil to the tank. Thus the quantity of oil used by the injection pump is replaced at a constant pressure. The transfer pump is cam operated from the same cam shaft that operates the metering or injection pumps. An overflow valve is located on the top of the injection pump housing. If it is necessary to remove this pump for cleaning or testing, first shut off the fuel supply, then wash off the entire assembly, including the fittings, with clean fuel oil. Remove inlet and outlet supply lines and drain the oil from the injection pump by removing the oil drain which is so marked. Remove the three nuts from the mounting studs and carefully pull out the pump. To release the valve and plunger springs, unscrew the retaining screws. The valves and the plunger may then be taken out of the assembly. Examine the valves and the seats. These should be clean and smooth. If it is evident that the seats need refinishing, this must be done with a valve seat reconditioning tool. The valves may be turned down, if necessary, by taking a light cut in a speed lathe. If this cannot be done, the parts should be replaced. The tappet assembly can be removed by taking out the retaining pin. Examine all parts of this assembly for wear. If excessive wear is evident between tappet roller and pin, both parts should be replaced. The operation of the pump may be tested by connecting a length of tubing to the suction side of the pump. Place the free end of the tubing in a container of oil and operate the tappet assembly by hand or with a tool until fuel oil flows from the outlet side of the pump. This should occur after about 75 or 100 strokes of the tappet assembly. If the transfer pump will not prime after reinstallation remove the inlet screw and put in a few drops of lubricating oil.

i. *Overflow Valve*—If the overflow valve, located in the top section of the injection pump, is held open by any foreign matter, the desired pressure on the fuel oil will not be maintained and some slight loss of power in the engine may be evident. This valve is very simple in operation and is easily removed for examination. The valve spring and valve can be removed by taking off the holding screw. The valve and valve seat should be carefully examined and if badly damaged replacements should be made. When reinstalling the overflow valve on the pump housing, tighten the nut firmly but not excessively as care must be exercised not to damage the injection pump housing.

j. *Supply Pump*—The supply pump, fig. 12, located low down and forward on the manifold side of the engine, draws oil from the storage tank through a strainer and delivers it to the intermediate or day tank. It is precision built and should give no trouble, and its operation should not be altered in any way. The pump is belt driven. To adjust the tension of the belt, loosen the pump mounting bolts and slide the pump toward or away from the engine to give a slack in the belt of ¾ or 1 inch midway between the pulleys. When correct adjustment has been made, be sure and tighten the holding bolts securely.

k. *Supply Pump Strainer* — The supply pump strainer, located below the pump, should be cleaned once a week or every 60 hours of operation. Shut off the oil at the valve under the day tank, and in case of a gravity feed from the storage tank shut the oil off here also. Disconnect the piping to the strainer, and then by removing the cap nut, at the top of the strainer, the screen can be lifted out of the strainer body. Wash this thoroughly with clean fuel oil or kerosene. A gasket fits between the cap nut and the strainer body. If this is not in good condition, replace it. To reassemble, reverse the above procedure.

14. AIR VENTS AND WATER DRAINS

a. *Note*—The engine will not run properly on the Diesel cycle if there is any air in the fuel system. A loss of power and missing of the engine frequently results from the system not being properly vented.

If the fuel oil has been drained from the day tank or the filter, or any fuel piping disconnected, or if air has inadvertently entered the equipment it will be necessary to vent the system. Air is vented at the fuel oil filter and the nozzles. However, before bleeding at these points be sure that the day tank is filled with fuel oil.

b. *Venting the Filter*—The fuel oil filter is the forward one of the three mounted on a bracket on the left side of the engine. (See fig. No. 10.) The air vent is located in the top of the filter. While the engine is running on gasoline, open this vent and allow the fuel oil to flow out until it is evident that there is no air in the oil and no air bubbles are visible.

c. *Venting the Nozzles* — The nozzles should be vented while the engine is operating on the gasoline cycle. The vents are located in the side of each noz-

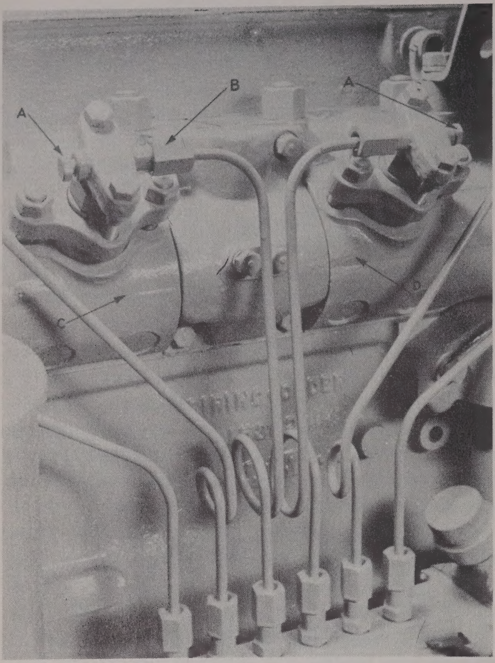

FIG. 18 — INJECTION NOZZLES

A—Nozzle Vents **C—Forward Cylinder Head**
B—Fuel Connection **D—Rear Cylinder Head**

zle. (See fig. 18.) Vent or bleed until the fuel oil flows free of air. Be sure these vent plugs are tightly screwed back in place.

d. *Water Drain in Day Tank* — A drain cock is located in the base of the intermediate or day tank. This cock should be opened and any water present drained out daily or whenever there is reason to believe there is water in the system. Drain sufficiently to be certain that any water present is entirely removed.

e. *Water Drain in Filter*—A drain cock is located in the bottom of the fuel oil filter. This cock should be opened and any water present drained out at least once a week or whenever there is reason to believe there is water in the system. Drain sufficiently to be certain that any water present is entirely removed.

15. REPLACING FUEL OIL FILTER ELEMENT

a. *Fuel Oil Filter*—The single fuel oil filter is the forward one of the three filters mounted on one bracket on the left side of the engine. A loss of engine power and missing of the engine at full load may be due to an inadequate supply of oil due to plugging of this filter. The filter has two elements, a cloth one and a metal one. These are cleanable and should be cleaned at least every 100 hours of engine operation. Before removing the elements, drain out the fuel oil in the assembly by opening the water drain in the base and then wash off shell exterior with clean fuel oil. The filters are removed by unscrewing the hold down bolt and lifting the shell from the base. Remove the elements and the gaskets. Rinse the inside of the shell and also clean the filter base thoroughly with fuel oil or kerosene. Wash both the cloth and metal elements in fuel oil or kerosene. When assembling be sure to install the gasket carefully. This should be replaced unless the old one is in good condition. Assemble the two elements and install them on the base. Replace the shell and hold-down bolt and draw the shell down tight.

16. ELECTRIC STARTING

a. *Starting Motor* — The starting motor, which is a Delco-Remy #1109106, is not likely to require much service or repair. If sparking occurs, it will be necessary to clean the commutator and adjust or replace the brushes. These are not easily reached for adjustment or cleaning unless the commutator end of the frame is removed. The removal of six bolts will allow the plate to be taken off when these parts will be easily accessible.

b. *Commutator, Cleaning*—To clean or polish the commutator, use No. 4/0 *sandpaper. Never* use emery or carborundum as particles of these substances will short circuit the commutator segments. Cut the sandpaper in strips about the width of the commutator and with the sanded side against the commutator work it back and forth across the segments, using care to continue this polishing action as uniformly as possible around the entire commutator. After polishing wipe off commutator with a dry lintless cloth.

c. *Brushes*—Check the brushes and see that they move freely in the brush holders. The curve of the contact surfaces of the brushes should be the same as the curve of the commutator. If this is not so, reverse the sandpaper and use as described in 16-*b* above. The last "stroke" of the sandpaper should be in the direction of rotation of the starting motor. Standing at the radiator of the unit and facing it, the engine runs clockwise so the starting motor runs counter-clockwise.

d. *Bendix Drive* — If for any reason the starting motor is removed entirely, which is done by unbolting it from the flywheel housing, the shaft of the Bendix drive should be lubricated. In any event, this should be done every six months. No oil or grease should be put on the drive gear.

17. STORAGE BATTERY

a. *Care of Storage Battery*—The two storage batteries must be examined periodically to see that the electrolyte covers the plates. This can be seen by removing the caps. If the electrolyte is low, add distilled water or rain water to bring the level about ½ inch over the plates. Raising the level over this amount will do no harm but it must not come nearer than ⅛ inch to the top of the battery. This examination must be made in each cell of each battery. The lowering of the level of the electrolyte is due only to evaporation of the water in the solution and not the acid and naturally occurs more rapidly under warm operating conditions. Definite periods for this examination cannot be stated. Every three weeks is suggested. Hydrometer readings should be taken at the time of this examination to check the charging of the batteries. CAUTION: IF THE ELECTROLYTE IS SPILLED OR COMES IN CONTACT WITH THE CLOTHING OR HANDS, ETC., RINSE IMMEDIATELY WITH A LIBERAL SUPPLY OF WATER.

b. *Battery Terminals*—Battery terminals should be checked about every month to see that the connections are well made and tight. See that the terminals are liberally covered with petrolatum or vaseline to prevent the accumulation of salts which corrode the terminals and connections.

18. STARTING SWITCH INSPECTION

The starter switch on the instrument panel should be examined occasionally to see that the contacts are clean and the battery cable connection is tight. The frequency of this examination cannot be definitely stated. However, it will be necessary to examine it often if the unit is being operated near salt water as corrosion of exposed or unpainted metal occurs rapidly under these conditions.

19. BATTERY CHARGING GENERATOR

a. *General*—The information given for the starting motor under 16-*a*, *b* and c above, apply also to the battery charging generator. Supplementing these, however, is the necessity for lubricating the bearings every week of operation, in the capped oil holes provided, with oil of the grade being used in the crankcase. Also, this generator is belt driven and the tightness of the belt should be checked. It is adjustable by loosening the bolt in the bracket that holds the generator in place, and also loosening the link which regulates the distance the generator is held from the engine. The generator can then be moved in the necessary direction to obtain the desired belt tension. In order to eliminate radio interference, a .25 microfarad condenser is connected from the armature to the ground.

20. BATTERY CUT OUT SWITCH AND VOLTAGE REGULATOR

a. *Cut out Switch*—The battery cut out switch or circuit breaker is located on the top of the charging generator in one housing with the voltage regulator. It is easily removed for inspection or service after taking off the drip guard which protects the generator.

b. *Operation of Cut out Switch* — The generator must be connected to the battery while operating, in order to charge it, but instantly that the engine is shut down this connection must be broken otherwise the battery would discharge through the generator and the large amount of current available from the battery would be likely to seriously damage the generator if it did not ruin it completely. The cut out switch accomplishes this purpose. The switch is magnetic in operation, the solenoid having two windings, one a voltage or shunt winding of many turns of fine wire and a current winding of a few turns of heavy wire. The same side of the shunt winding is always grounded so current always flows through it in one direction which acts to close the switch. The current winding works with the shunt winding to close an armature type switch while the generator or engine is operating. However, when the generator stops the battery current flows through the solenoid in the opposite direction to that of the generator current. This battery current counteracts the effect of the shunt winding and the armature type switch is immediately opened. An ammeter indicating charging or discharging rate is located on the engine instrument panel. This ammeter should be observed frequently and if at any time it shows a very high reading on the discharge side, either while the engine is operating or idle, steps should be taken to correct this condition as rapidly as possible. Probably the quickest way is to disconnect the wires leading to the terminals on the charging generator. Investigation should then be made of the contacts of the armature switch. If pitted they should be filed smooth, being careful to remove all filings.

c. *Voltage Regulator*—The battery charging voltage regulator is a switch which is opened and closed magnetically. It regulates the charging voltage of the generator and prevents excessive voltage, which would damage the battery, due to overcharging.

d. *Operation of Voltage Regulator* — As noted above, the generator must be connected to the battery in order to charge it. However, provision must be made to prevent over charging. The voltage regulator consists of a solenoid to operate an armature type switch which cuts in or short circuits a resistance as required. The solenoid is wound with many turns of fine wire connected across the generator, and a series winding of heavier wire carrying the field current to ground. The armature over the solenoid is held away from it by a spring, and in this position a pair of contact points, one on the armature and one above it, are held together, the generator field circuit is directly grounded and the resistance is short-circuited. It should be remembered that one side of the battery is grounded and the other side is connected to the generator, during operation, through the cut-out switch. With the armature contacts made and the resistance short-circuited, the generator will produce the maximum charging effect on the battery. When the battery has become sufficiently charged, the voltage of the battery will have increased enough to overcome the armature spring tension and the contacts will be opened. This cuts in the resistance in the generator field circuit and the generator output drops off. The value of the resistance is fixed and cannot be altered. An armature stop prevents the armature from contacting the core of the solenoid. If the battery becomes partially discharged, the magnetic field of the solenoid is reduced and the armature spring draws the armature away from the solenoid and the contacts referred to above are again made, short-circuiting the resistance, and a charging current again flows into the battery. When the engine is shut down and the cut-out switch is opened, as described in section D-20-*b*, the voltage regulator switch circuit is also opened so that no battery current flows through the regulator solenoid. The operation of the regulator can be determined by frequent observation of the ammeter on the engine instrument panel. The contact points on the armature switch should be examined and if rough or pitted should be filed smooth. The voltage regulator circuit is opened, when the engine is not operating, by the opening of the above described cut-out switch. Note: On a fully charged battery, the ammeter may show no charging rate. A check on the operation of this can be made by operating the electric starter several times, thus reducing the charge in the battery. Under this condition the ammeter should show a charge going into the battery.

21. SAFETY SYSTEM

a. *Test of Alarm Devices*—A daily test must be made of the Fulton-Sylphon safety device to determine that it is in reliable working order. As explained in Section C-11-*a*, this unit is purely mechanical and any failure will operate to shut down the engine. A check on the operation is made by releasing the trigger, which is done with the setting lever projecting from the side of the housing. In event of a failure, remove the cover and determine that the poppets move freely. Examine the springs and if they are broken replace them. Then tests should be made with the circuit breaker open, otherwise be sure to open the breaker before starting the engine after the tests.

22. EXHAUST SYSTEM

a. *Cleaning*—It will be advisable to inspect the interior of the exhaust piping or flexible metal hose after it has been in service for about one month, and if an appreciable amount of carbon or other deposit is evident, the entire exhaust system should be dismantled and thoroughly cleaned. If it is found to be clean, repeat the inspection in about another month and try to determine at what regular period of time a thorough cleaning should be made, and then follow this schedule. It is difficult to say just how often the exhaust system should be cleaned as it depends on the operation of each individual engine. If the system is dismantled, be sure that all joints are well made when reassembled. It is important that no leaks be permitted in the exhaust system.

23. COUPLING

a. *Maintenance*—There is very little to go wrong with the Ajax 2BO coupling (Figs. 19 and 20).

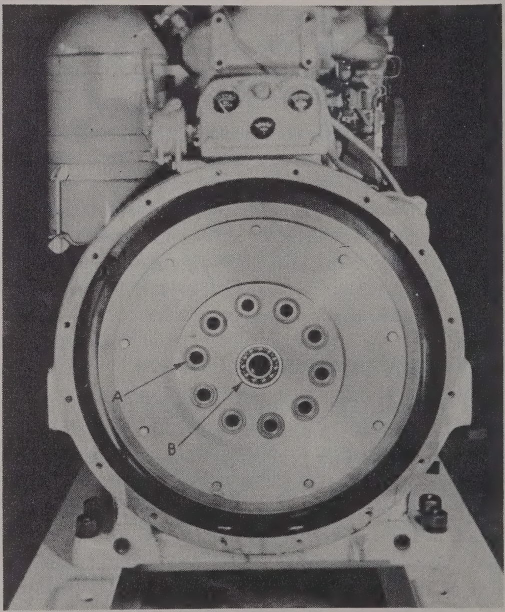

FIG. 19 — COUPLING, FLANGE HALF
A—Rubber Bushed Bronze Bearings
B—Pilot Ball Bearing

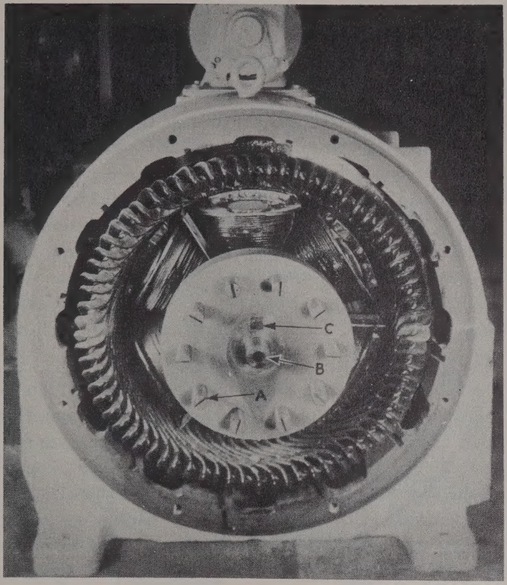

FIG. 20 — COUPLING, HUB HALF

A—Pins to Engage Flange Half of Coupling
B—Alternator Shaft C—Key

Wear of the parts and any deterioration of the rubber bushings should be extremely slow. The necessity for replacement of the bushing in the section bolted to the engine flywheel or the pins in the hub half will be evident by a knocking noise. The bushings are cemented in place. These will have to be pried or dug out. Replacement bushings and pins are included in the spare parts, as is also the holding cement. In installing these, thoroughly coat the wall of the recess for the bushing and also the outside surface of the rubber. Before the cement has had a chance to dry, insert the end of the bushing which has been bevelled, and with a lever or a block of soft wood and a hammer force the bushing in until it is flush with the inner face. The pins in the hub half of the coupling are threaded in place and also held by a nut and lock washer. The removal and replacement of these pins is very evident. The bolts that hold the flange half of the coupling to the flywheel should be examined every two or three months to see if they need tightening. In event of a knocking noise, as mentioned above, these bolts should be checked, and also the tightness of the pins in the hub half of the coupling, before replacing any bushings.

24. INTAKE MANIFOLD

a. ***Description***—The cast iron dual intake manifold, as described in section A-2-e, contains the magneto grounding, switch and the air valve which controls the section of the manifold which is being used, that is for gasoline or for Diesel operation.

b. ***Removal of Intake Manifold***—It will be necessary to remove this manifold in order to replace any gaskets, if this is necessary, or if the cylinder head is to be removed. In order to take off the manifold, the carburetor and the connection to the air cleaner will have to be removed. To take off the carburetor, first disconnect the gasoline after shutting off the gas supply at the gasoline tank. Then disconnect the link which controls the gasoline shut-off device which operates when the engine is running on Diesel cycle. This is done by removing the cotter pin which holds the link in the carburetor lever. The air cleaner connection, which extends over the top of the engine, is taken off by removing the four bolts on each end of the section that runs from the intake manifold to the air cleaner. The magneto grounding wire will have to be removed either at the switch in the manifold or at the magneto. The intake manifold can then be easily removed by taking the nuts off the eight studs which hold it in place.

c. ***Replacing the Intake Manifold***—Do not replace the intake manifold without examining the gaskets carefully. Usually whenever any gasketed parts are removed the gaskets are damaged. Replace any necessary, being sure that no fragments of the old gaskets stick to the flanged surfaces of the cylinder head or manifold. On copper-faced gaskets, be sure that the edges of the thin copper are not turned over. Discard any such gaskets unless they can be flattened perfectly.

d. ***Magneto Grounding Switch*** — The magneto grounding switch is located on the valve lever mechanism which operates the compression release valves. A copper contact (3) fig. 11, is attached to valve lever (1). This makes contact with insulated connection (4), grounding the magneto when the valve is closed for Diesel operation and removing this ground when the valve is in the gasoline operating position. In this latter position, the magneto is allowed to distribute high voltage current to the spark plugs. Of course, on gasoline operation the satisfactory performance of this switch will be evident if the engine runs satisfactorily on this cycle. However, when the engine is operated on the Diesel cycle there should be no spark on the spark plugs as the magneto should then be grounded. An occasional check of this should be made. An insulated handle screwdriver can be used by having the blade touching the metal of the engine while bringing the point of the blade very near to the plug being tested, and finally touching the center terminal of the plug. No spark should occur. If a spark occurs, operate the compression release several times, which may remove the trouble by resulting in a contact of the grounding switch, and then test the plugs again. If the trouble continues, it will be necessary to remove the housing section of the intake manifold over the carburetor and clean the contacts of the switch. It also will be advisable to see that the ground connection on the magneto is in satisfactory condition.

25. GASOLINE SYSTEM

a. *General* — The gasoline system comprises the gasoline tank, bolted to the shell of the radiator on the left side of the engine; a shut-off cock in the gasoline lines; a combination sediment bowl and strainer located near the gasoline tank; a carburetor located below the intake manifold; a manually operated priming pump located to the rear of the carburetor, and the necessary piping, etc. NOTE: It is advisable to turn off the gasoline at the shut-off cock after the engine is operating satisfactorily on Diesel cycle.

b. *Gasoline Tank*—The gasoline tank should be examined occasionally for small leaks. Large leaks would be perfectly evident. If it is necessary to solder the tank, it must be thoroughly dried out before this is done. The use of an air line is the best way to accomplish this.

c. *Gasoline Shut-Off Valve* — If this valve leaks, tighten up the screw on the back of the valve so that the rotating part, which is tapered, will be drawn into its seat.

d. *Sediment Bowl and Strainer* — The sediment bowl and strainer should be cleaned at least once a month, or oftener if much sediment has collected in the bowl. The procedure for this is as follows:

(1) Close the gasoline shut-off valve.

(2) Loosen the jam nut under the sediment bowl, being careful to hold the bowl in place, and swing the frame, holding the bowl in place, to one side when the bowl may be lifted out.

(3) The strainer is a fine screen which fits in the top of the sediment bowl. Remove this and also the cork gasket.

(4) Rinse the bowl with gasoline or kerosene and wipe out with a clean lintless cloth.

(5) Clean the strainer with a brush and gasoline, being careful not to bend it.

(6) Reassemble the parts, replacing the cork gasket with a new one if necessary. The jam nut should be screwed up just sufficiently to hold the bowl firmly in place. Too much pressure of the jam nut on the bowl is very likely to break it. If this bowl is broken and none other is available, remove the entire unit and connect the gasoline direct to the gas tank line. Replace as soon as possible, but do not put the generating unit out of service for this reason.

(7) Turn on the gasoline valve and examine for leaks.

e. *Carburetor*—As the carburetor is used only for the starting period and is completely out of service during Diesel operation, it should require very little service and wear over a long period should be negligible. There is no adjustment possible of the needle valve, and while the air intake can be altered, this is set correctly at the plant of the supplier and should require no alteration. Certain things may have to be done. These are described in the following sections:

f. *Carburetor Fuel Bowl*—The fuel bowl, which is the lower section of the carburetor, contains the float assembly and a strainer. The float assembly includes a cork float, a needle valve and seat, and a metal strip fastened to the float. This metal strip, which extends to a collar on the needle valve, is formed so that a pin, covered with a sleeve, projects through the strip near the needle valve end, this pin acting as a hinge or fulcrum. When the gasoline level in the bowl is reduced, the float drops down and therefore the needle valve is raised from its seat and gasoline flows into the bowl until the proper level is reached when the rising float shuts the needle valve and cuts off the flow of gasoline. There is also a flat spring projecting upward at an angle, held to the float by the same bolt that holds the flat strip to the float. The purpose of this spring is to force the float up—thus shutting off the gasoline supply, when a cam is rotated by the lever which changes the engine from gasoline to oil operation. This action is described in section C-3.

g. *Carburetor Float Level*—The float level controls the gasoline level which is normally about 13/32 inches below the top of the bowl. With gasoline at this level and the needle valve held firmly on its seat the float is ¼ inch below the top of the bowl.

h. *Carburetor Needle Valve*—If there is a noticeable continued flooding of the carburetor, it is likely that some dirt has got in the seat of the needle valve or that it is worn and does not seat properly. With the float removed, the needle valve and seat are very easily taken out for inspection and cleaning. The valve can be wiped off with a soft cloth and the cloth may be placed over the seat and the valve used in position and rotated to clean the seat. Under no circumstances, use a pin or wire or any similar device in the opening of the valve seat. If the valve or valve seat are worn or pitted or show definite circular ridges, have them replaced. They are furnished in pairs only, as a used valve will not fit on a new seat or vice versa.

i. *Gasoline Strainer*—The gasoline strainer, located in the gasoline intake section of the carburetor, should be cleaned periodically. Close the gasoline shut off cock and disconnect the gasoline line from the carburetor and remove the strainer fitting which includes the strainer. (See Fig. 21.) Wash this off with kerosene and reassemble. Be sure to open the gasoline valve when assembly is complete and check for leaks.

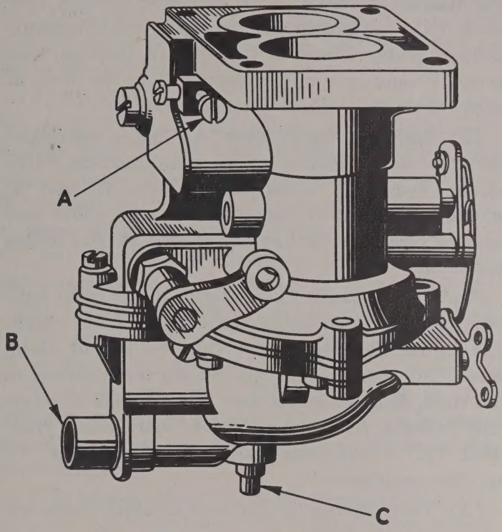

FIG. 21 — CARBURETOR

A—Idling Speed Adjusting Screw
B—Strainer C—Drain

j. *Idle Speed Adjustment* — An idle speed stop screw is provided on the carburetor. (See Fig. 21.) The throttle lever comes in contact with this screw so that the position of this screw controls the idle speed of the engine while operating on gasoline. Loosening the lock nut on this screw and turning the screw out reduces the speed of the engine. The engine speed when operating on gasoline should not exceed 800 R.P.M. If the engine is operated in cold locations, it will be necessary to open the throttle slightly, by adjusting the stop screw in order to maintain the idling speed.

k. *Choke and Priming Pump*—The carburetor is provided with a choke and a priming pump. (See Fig. 9.) It will be necessary to use the choke when starting, particularly if the engine is cold. The closing of the choke supplies a greater quantity of gasoline to the engine, which facilitates starting. As soon as it is evident that the engine is running smoothly, open the choke, as continued operation with the choke closed will cause the engine to stop due to flooding of the carburetor and it will be necessary to wait for the excess gasoline to evaporate before starting can be accomplished.

The purpose of the priming pump, located near and to the rear of the carburetor, is to inject gasoline into the intake manifold to facilitate starting the engine under extremely low temperatures. Small tubing leads from the pump to the forward and rear sections of the intake manifold. The pump is manually operated and usually one stroke of the pump, coupled with the use of the choke, will be sufficient to overcome difficult starting. If the engine does not start easily, do not continue trying, as to do so will run the batteries down. Check to see that the engine is getting gasoline and if so check the ignition as described in section D-1.

26. CYLINDER HEADS

a. *General*—While the engine block is cast in one piece to include the six cylinders, the cylinder head is cast in two sections, each section being a cylinder head for three cylinders. These heads are water-jacketed as is also the cylinder block. A copper covered asbestos gasket is used between the cylinder heads and the cylinder block. This gasket is properly punched out in order that the water may circulate around the cylinder walls. The cylinder head carries the intake and exhaust manifolds; the valve mechanism including the compression release valves; the fuel oil injector nozzles and the spark plugs. The two thermostats are in a single housing bolted to the front end of the forward cylinder head. As all valves are of the overhead type, a housing is used to cover the entire valve assembly.

b. *Cylinder Head Removal*—Either of the two sections may be removed independently of the other. To do so, take off the valve cover, valve housing with the valve assembly, intake manifold, the high pressure tubing, the water manifold, spark plug wires and the controls. The cylinder head nuts can then be removed and the head lifted off.

c. *Replacing Cylinder Head* — The cylinder head gasket is assembled to the engine with three elongated holes toward the injection pump side. The same type gasket is used for both front and rear cylinder head.

The copper gasket rings located on top of the cylinder sleeves become hardened in use and should be annealed to restore the flexibility before reassembling head. To do so, bring them to a dull red heat and quench in water. Use of new rings or properly annealed ones assure a gas tight seal between head and sleeve. The flange side of the copper rings should always be uppermost.

The valve guides in the head are replaceable. They are assembled with chamfered end to the top.

The top of the starting valve guides are 1-1/16" BELOW upper surface of head and the others are 1-7/32" above this surface.

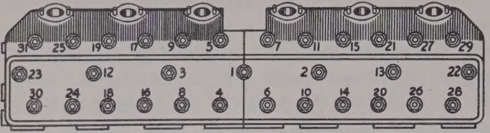

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FIG. 22 — CYLINDER HEAD NUT TIGHTENING SEQUENCE

When replacing cylinder heads have all surfaces clean, gaskets and rings in place and then check heads for alignment with straight edge across the manifold side. Center stud nut has a washer which contracts both heads. Run all nuts down with a speed wrench and then start at center and progressively tighten nuts as indicated in Fig. 22. Then use a torque tension wrench, following the numbered sequence, and draw all nuts down to 170 ft. lbs.

27. STARTING CONTROLS

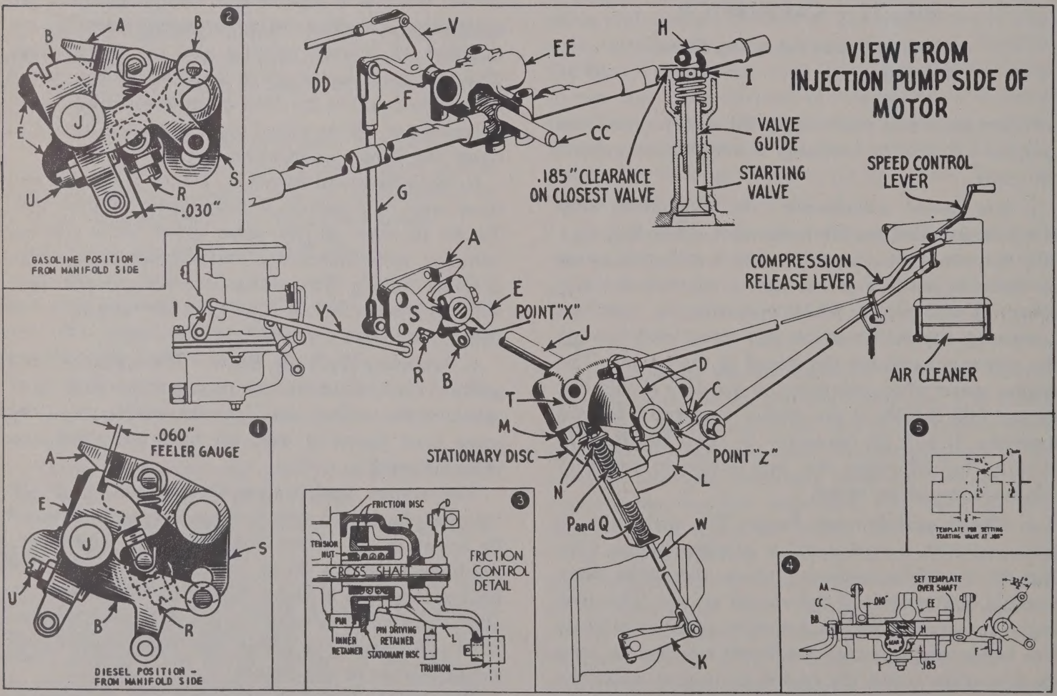
a. *Adjustment*—If engine controls have been removed for any reason, the first thing to do is to assemble all controls, cross shafts and their levers as shown in Fig. 23 and its inserts. Do not assemble intake manifold and valve cover, nor connect yoke "F" to the lever "V." Lower shaft "J", should have .030 inch end play when checked between lever "D" and bracket "T," then proceed as follows:

(1) Make a sheet metal template according to the diagram of Insert No. 5 and slide opening over shaft "CC." Let prongs rest on top of valve housing, without gasket. Insert a ¼ inch pin through both lever "V" and hole in template to hold the lever at 32½° with the vertical (Insert No. 4).

(2) Spring on top of lever "AA" holds the rollers "H" for each cylinder away from starting valve spring retainer "I." Clearance between "H" and "I" should be .185 inch minimum for each roller and greatest clearance for any one should be .205 inches maximum.

Place .185 inch (3/16 inch) gage under roller with least clearance and adjust set screw "BB" to obtain this figure. The lever "AA" may be moved along shaft "CC" if screw "B" requires much movement to the right. Replace cotter key. Adjustments of screw "BB" rotates the starting valve shaft when cross shaft "CC" is held from rotating by pin in lever "V" and the template.

(3) There should be .010 inch clearance between



②
B
A
B
E
J
S
U
R
.030"
GASOLINE POSITION - FROM MANIFOLD SIDE
V
DD
EE
F
CC
G
H
I
VIEW FROM INJECTION PUMP SIDE OF MOTOR
VALVE GUIDE
STARTING VALVE
.185" CLEARANCE ON CLOSEST VALVE
SPEED CONTROL LEVER
COMPRESSION RELEASE LEVER
AIR CLEANER
A
I
Y
S
E
POINT "X"
J
R
B
D
C
T
M
STATIONARY DISC
POINT "Z"
L
N
P and Q
W
K
①
.060" FEELER GAUGE
A
E
J
S
U
B
R
DIESEL POSITION - FROM MANIFOLD SIDE
③
FRICTION DISC
D
T
TENSION NUT
CROSS SHAFT
FRICTION CONTROL DETAIL
PIN
INNER RETAINER
STATIONARY DISC
PIN DRIVING RETAINER
L
TRUNION
⑤
TEMPLATE FOR SETTING STARTING VALVE AT .185"
④
AA
CC
BB
.010"
SET TEMPLATE OVER SHAFT
EE
32½°
V
H
F
I
.185

FIG. 23 — STARTING CONTROLS

lever "AA" and bracket "DD" after setting valve clearance.

(4) Back off set screws on the following levers: "R" on release lever bracket "S," "C" on cross shaft bracket "T" and "U" on jaw lever "B."

(5) Set compression release lever for Diesel operation. Latch "A" should be engaged behind jaw "B." Adjust set screw "R" in bracket "S" for .060 inch clearance between jaw "B" and latch "A" as shown in the Insert No. 1.

(6) Holding jaw "B" against set screw "R," adjust yoke "F" on rod "G" so that pin can be slipped through yoke "F" into lever "V." Replace cotter key.

(7) Lower compression release lever until lever "E," behind jaw "B," contacts the offset pick up face on lever "B" at the point "X." Now adjust set screw "C," on opposite side of engine, to give .100 inch between set screw "C" and lever "D" at the point "Z."

(8) Lower compression release lever to starting position or until latch "A" locks behind notch in jaw "B" as shown in the Insert No. 2.

(9) Adjust set screw "U" in lever "B" to give .030 inch overtravel to lever "B." Measure between end of set screw and bracket "S" as shown in the Insert No. 2.

(10) Attach intake manifold to engine and connect rod "DD" to lever "V." Adjust yoke on rod "DD" to have pin in lever on air valve approximately centered in slot on end of rod "DD" (Illustration 38).

(11) Trip mechanism to Diesel position and check for the centering in slot. Adjust yoke to obtain best balance of centering pin in slot for both Diesel and gasoline operating positions.

(12) Connect link "Y" between carburetor and lever "B."

(13) Start engine and run at idle speed on Diesel cycle. Finger on lever "L" should just contact spring plunger "M" in bracket "T." If injection pump has been replaced, lever "K" can be set on the serrations of its shaft to make engine idle at this position of the controls. Further adjustment can be made by removing rod "W" and turning nuts "N" until engine idles with the finger of "L" contacting plunger "M."

(14) Lower speed control lever all the way for shut-off position of pump. Plunger "M" should extend 3/32 inch from boss of bracket "T." Adjust yoke on speed control rod to accommodate complete pump shut-off if necessary. Spring "P" should be slightly compressed but not compressed solid. There is always tension on springs "P" and "Q" for cushioning the governor when operating.

(15) Operate engine at full throttle and inspect spring "Q." It too should be compressed at this position. Adjustment of stop screw on air cleaner will provide proper tension on spring.

b. *Operation*—With speed control lever in shut-off position, lowering the compression release lever to gasoline starting position moves top of lever "D" to the rear, turns cross shaft "J" in crankcase which rotates bottom of lever "E" toward the front until it contacts lever "B" at point "X." "E" turns lever "B" until latch "A" drops down behind notch in lever "B," holding it in that position until changing to Diesel operation. (See Insert No. 2.)

As lever "B" starts to turn, rod "G" is raised, rotating lever "V" and shaft "CC" against tension of spring attached to lever "AA." Gear on shaft "CC" turns gear of starting valve shaft pressing roller "H" against retainer "I" and opening starting valve. With valve open, compression ratio is reduced for gasoline starting.

As lever "B" rotates, link "Y" is also advanced to the front, removing cam from spring on flat in carburetor, allowing needle valve to operate and admit the gasoline from supply tank.

Lever "V" pushes rod "DD" as it rotates and this movement to the rear turns shaft in air valve housing. Valve lever (1) of fig. 11 is keyed to the shaft and is turned upward, lifting air valve from its lower seat. As soon as lever (1) gets beyond center position, the spring in air valve housing snaps valve against its upper seat. Air path is then down through the carburetor and to the manifold through opening formerly covered by air valve when on its lower seat. Copper contact (3) attached to valve lever (1) is also lifted off insulated contact (4) breaking ground connection to the magneto, allowing it to distribute high voltage current to the spark plugs.

After starting on gasoline, compression release lever is raised for change to Diesel operation. Raising the lever, advances top of lever "D" to the front, turns cross shaft "J" and rotates lever "E." Upper rounded end of lever "E" contacts latch "A," raising it sufficiently to release lever "B" from offset in lever "A." Spring tension on lever "AA" is applied to lever "B" through shaft "CC," lever "V" and rod "G." Lever "B," therefore, snaps completely around until it strikes set screw "R." In so doing, it pulls link "Y" which turns cam in carburetor back down on spring on float, forcing needle valve back on its seat, cutting off gasoline supply.

As rod "G" comes down with lever "B," lever "V" rotates with shaft "CC." Gear on shaft rotates starting valve shaft and lifts roller "H" off retainer "I," allowing starting valve spring to snap valve closed, increasing compression ratio for Diesel operation by cutting out the extra volume chambers in the head.

As lever "V" is turned, rod "DD" is pushed to the front, turning shaft in air valve housing, removing valve from upper seat until spring snaps valve against the lower seat. Air path is now direct to the manifold.

As lever (1) came down, contact (3) engaged contact (4) grounding magneto and thereby cutting off supply of high voltage current to spark plugs.

28. CONNECTING RODS

a. *Specifications* — Specifications for the connecting rods and bearings are included in the detail engine specifications.

b. *Removal*—The connecting rods and pistons are removed as an assembly after first removing the oil pan. Turn the crankshaft to one side after disconnecting the bearing cap and lifting the connecting rod from the crankshaft. The connecting rod and piston can then be pulled down and around the crankshaft.

c. *Bearings*—The connecting rod bearings are not adjustable so when wear becomes excessive, replacement is necessary. These bearings can be replaced without removing the piston or connecting rod. After removing the bearing cap, lift up the rod and slide out the bearing. The wear of the bearings can be checked by placing a .003 inch brass shim, ¼ inch wide and 1¼ inches long between the lower bearing and the crankshaft. The drag of this gage indicates the amount of clearance. If it slides easily, the wear in the bearing is excessive and it should be replaced. When replacing connecting rod bearings, clean the bearings, rod and bearing cap. Engage the nib on bearings in the milled slots of the connecting rod and the cap and lubricate the bearing surface. NOTE: Cylinder numbers are stamped on one side of the cap and the connecting rod and the crankcase is stamped with the main bearing numbers. Assemble the caps and rods with the numbered side toward the numbered side of the crankcase. Draw up the cap bolts evenly using a torque tension wrench to 70 pounds. Line up the slots in the nuts with the holes in the bolts. Tighten nuts rather than back them off to make this hole line up. Replace the cotter keys.

29. CRANKSHAFT

a. *Specifications*—Specifications for the crankshaft and bearings are included in the detail engine specifications.

b. *Bearings*—The crankshaft is held in the cylinder block by seven copper lead, steel back bearings set in hardened bearing journals which are drilled for pressure lubrication to the connecting rod bearings. The bearings are held to the crankcase with nuts on ¾ inch studs. The crankshaft is counterbalanced with counterbalances which are an integral part of the crankshaft. Each bearing cap is numbered and a corresponding number is stamped on the crankcase. In case these bearings are taken out, care should be used to replace them so that corresponding numbers agree. The center bearing is a thrust bearing. After removing the oil pan, the other six bearings can be replaced but in order to replace the center bearing, it will be necessary to remove the lubricating oil pump. The running clearance of the bearings can be checked as described in the foregoing section D-28 CONNECTING RODS, that is a .003 inch gage should have a drag when inserted between the crankshaft and a bearing. To check the end clearance at the center bearing, force the crankshaft forward using a block of wood. The clearance at this thrust bearing should be .008 inch minimum and .012 inch maximum. When replacing bearings be sure the crankshaft, cap and bearing are clean. The upper bearing can be removed from the crankshaft and the case by turning the crankshaft while pushing on the bearing shell with a piece of flexible metal being careful not to score or scratch the crankshaft. When installing new bearings, engage the nibs of the bearings in the milled grooves in the crankcase and cap. Replace washers and nuts and tighten evenly using a torque tension wrench to 150 foot pounds. Insert the cotter pins tightening the nuts further rather than backing them off in order to line up the holes for the cotter pins.

30. PISTON ASSEMBLY

a. *Removal of Pistons* — The pistons may be removed after taking off the oil pan and removing the bearing cap and lifting the connecting rod from the crankshaft. The connecting rod and piston can then be pulled down and around the crankshaft. In reinstalling pistons, be sure that these are replaced in the same cylinder from which they were removed.

b. *Piston Rings*—The pistons, made of aluminum alloy, are fitted with 6 rings, 4 compression and 2 oil controls. Dimensions, clearances, etc., of these rings are covered in the detail engine specifications. The four compression rings and one oil control ring are located above the piston pin and the other oil control ring is below the pin. The fourth ring from the top is tapered. The top of this ring is marked "Top" and this surface must be assembled toward the top of the piston. When replacing rings, the gaps should be staggered around the piston so that no gap is directly above the gap of an adjacent ring. See that all ring grooves are clean, giving particular care to the sides of the grooves, and free from carbon and that the oil holes in the oil control ring grooves are cleaned out and free for the passage of oil. In cleaning the ring grooves be careful not to scratch or score the piston.

c. *Piston Pins* — Piston pins are the full floating type and are secured in the pistons with snap rings. In order to remove or install these pins, it may be necessary to heat the piston in hot water as the expansion of the metal will be enough to make their removal easier. Detail specifications of the piston pins are covered in the engine specifications.

31. CYLINDER SLEEVES

a. *Inspection*—Before replacing sleeves which are believed to be worn, be sure that the indicated trouble is not due to stuck or worn piston rings. When it is necessary to replace any cylinder sleeve, a new piston and piston assembly must be installed. Pistons and sleeves are obtainable in sets and no honing or grinding is required for this assembly. Wear of the sleeve can easily be checked by forcing a piston ring into the bottom of the sleeve and at right angles to the operating position of the ring, having the gap up. Measure the opening of the gap and then move the ring upward to about 1½ inches below the top of the sleeve and measure the ring gap in this location. If the difference is more than .008 inch replace the sleeve.

b. *Removal of Sleeves* — Sleeves can readily be removed from the crankcase with a puller tool after the oil pan, cylinder head and pistons have been removed. They must be marked or systematically arranged so that they can be reinstalled in the counter bore from which they have been taken.

c. *Replacing Sleeves*—The sleeves are made watertight at the base by rubber packing rings. These must be removed from the grooves in the crankcase and new rubber rings installed before reinstalling or replacing the sleeves. Clean the ring grooves, the counter bore at the top and the water jacket. While doing this protect the crankshaft bearing journals with rags. Be sure the new rubber rings are free of all oil or grease. Coat the rings with a soap solution made of ½ ounce of glycerine to a tablespoon of soap flakes and place them in the grooves in the crankcase. The soap solution will prevent them from rolling out of place when the sleeve is installed. Apply the same soap solution to the bottom of the sleeve on the outside finished surface and lower them into position, being sure that the rubber ring is engaged all the way around on the taper of the sleeve. Wipe out the interior of the sleeve before replacing the cylinder head and pistons. The sleeves are held in place by the cylinder head.

32. CAMSHAFT

a. *General* — The camshaft is a one piece steel forging running in four steel backed babbitted bearings. It is driven through helical gears by the crankshaft. The camshaft, in turn, drives the lubricating oil pump and the magneto drive gear and also operates the tappets which open the intake and exhaust valve. It is equipped with a grey iron thrust plate.

b. *Camshaft Bearings*—Dimensions of the bearings and journals are given in the detail engine specifications. Bearings are furnished reamed to size, it being only necessary to press them into place, being sure to line up the holes in the bushing with the oil supply holes in the crankcase.

c. *Camshaft Assembly*—In order to complete the assembly of the camshaft, place the thrust plate on the shaft, put the key in the keyway and press the gear on the shaft. Then put on the nut lock and nut, bending over the nut lock to prevent the nut from becoming loose. The camshaft assembly is attached to the crankcase with two cap screws which are accessible through holes in the drive gear. The punch mark on the camshaft gear must match the mark on the idler gear when the "S" mark on the idler gear matches the "S" mark on the crankshaft gear. In this position, timing of the valves is correct.

33. VALVES

a. *Valves and Valve Mechanism*—The component parts of the exhaust and intake valve mechanism proper are the valve stem guides; the valve lever shafts or rocker arms; the push rods; the tappet and the valve springs. The camshaft which operates these valves is covered in above section D-32.

Note: If any valve parts are replaced or altered in any way, it will be necessary to adjust the valve levers as hereinafter described.

b. *Valve Stem Guides*—If the valve stem guides which are made of grey iron are worn, it is necessary that they be replaced as no efficient repair of this part can be made. These guides are furnished reamed to size, it being only necessary to press them in place with the sharp chamfered end up and 1-7/32 inches above the counterbore in the cylinder head. If it is necessary to drive them in use a soft metal rod. The bore for the valve stem guides and the valve seats should be concentric within .002 inch.

c. *Bushings* — The bushings in the valve lever shafts or rocker arms should be replaced if worn. These bushings must be reamed to size. The diameter is .9660 inch to .9665. In reaming these bushings be very careful to have the hole in the bushing line up with the hole in the lever. This valve lever assembly can be lifted out without removing the cylinder head. Refer to section D-26, "Cylinder Heads."

d. *Valve Push Rods* — The valve push rods are steel tubing with solid steel end inserts. These are removable from the top after taking off the crankcase side cover plates and the tappet stops.

e. *Valve Tappets*—The valve tappets which are fitted in the crankcase are removable from the top after taking off the crankcase side cover plates.

f. *Valve Springs* — The free length of the valve spring is 3-1/16 inches and under a load of 65 pounds it should measure 2½ inches. Valve springs that compress more than this under the specified load should be replaced. These springs should be tested under load as springs that have been in continued use frequently take a set so that the free length may be somewhat less than the figure specified. Examine carefully for broken springs, particularly at the ends of the springs.

g. *Valve Adjustment*—The amount of the clearance of the valve levers and the valve stems is very important and any adjustments should be carefully made. The valves must be allowed to close completely and in order that they are opened at exactly the right time very little clearance is permitted. Properly adjusted this clearance when the engine is hot is .018 inch. A feeler gage to be used for this clearance is part of the tool equipment supplied. Routine clearance checks should be made about every 400 hours of operation. Also if the valves or valve mechanism has been altered in any way or if any parts have been replaced, it will be necessary to adjust the valves. Obviously under these latter conditions the adjustment cannot be made on a hot engine but after adjustment the engine can be heated up and a final check or adjustment made. The cylinder head and valve mechanism must all be properly assembled before any adjustment is attempted. (Instructions for installing the cylinder head are given in section D-26.)

To adjust the valves proceed as follows:

(1) Remove the distributor from the magneto in order to prevent any spark while cranking the engine as will be necessary.

(2) Set the compression release lever in the position for gasoline operation.

(3) Valve housing must be removed.

(4) Remove the spark plugs from all of the cylinders.

(5) Place your thumb over the spark plug opening of the No. 1 cylinder and have an assistant crank the engine slowly until an outward pressure can be felt. This pressure indicates that the No. 1 piston is moving toward the upper dead center of the compression stroke.

(6) Continue the cranking slowly until the notch marked "D.C." on the fan drive pulley is in line with the timing pointer on the front of the crankcase cover. Both intake and exhaust valves are now closed on the compression stroke of the No. 1 cylinder.

(7) Loosen the lock nut and adjust the screw in the valve lever so that the feeler gage supplied in the tool kit slips snugly between the end of the valve lever and the valve stem. Tighten the lock nut and recheck the clearance. The thickness of this gage is .017 inch. NOTE: If the valve stem has worn a recess in the valve lever the feeler gage will not be an accurate measurement of the clearance. If this condition exists it is suggested that the check for the clearance of .017 inch be made at the valve tappet taking note of the degree or amount of turning of this that is necessary to give the desired clearance when the valve lever is in contact with the valve stem. With the feeler gage in place adjust the valve lever to make contact with the valve stem. Remove the feeler gage and turn the tappet back to its original position.

(8) Crank the engine slowly ½ a revolution at a time and check the clearance of each cylinder's valves and adjust if necessary. The order of firing of the cylinders is 1-5-3-6-2-4 so the second set of valves to check will be those of cylinder No. 5, then No. 3, 6, 2 and 4.

(9) Replace the valve housing making sure that the gasket makes an oil tight seal with the cylinder head.

(10) Replace the magneto distributor and the spark plugs.

h. *Valve Grinding*—Valves should not be ground unless it is perfectly evident that it is necessary as grinding shortens the life of the valves. The most common evidence that grinding is necessary is loss of compression and consequent loss of power. While worn cylinder liners or stuck piston rings will also result in loss of compression, these latter conditions, should they exist, will result in an excessive amount of lubricating oil being used and probably a blue smoke from the exhaust, due to the burning of this oil over the pistons. It will be necessary to remove the cylinder head in order to grind the valves. Reference to the detail engine specifications will show that for grinding purposes, the valves have the following dimensions:

	VALVE SEAT WIDTH	VALVE SEAT ANGLE	HEAD DIA.	PORT. DIA.
Intake	3/32″	45°	2″	1.780″
Exhaust	3/32″	45°	1¾″	1.530″

Clean or scrape all carbon from the valve stems and guides. If a motor driven valve guide cleaning brush is available, use it, but if not the valve guides can be cleaned by wrapping a piece of fine emery cloth around a rod and rotating it in the guide until all carbon is removed. The valve stems can be cleaned by rubbing lightly with emery cloth. Be sure all emery residue is removed. Try each valve in its guide and be sure that it is free. CAUTION: EACH VALVE MUST BE FITTED TO ITS OWN SEAT. NEGLECT OF THIS WILL RESULT IN EXCESSIVE GRINDING BEING NECESSARY.

Clean off all carbon from the cylinder head and pistons. Remove one valve and coat lightly with valve grinding compound and insert it in the cylinder head in its proper place. Use a valve grinding tool in the slot in the valve and rotate it 30 or 40 turns. Remove the valve from the head and wipe the compound from the valve and the valve seat. Examine the valve seat and the valve face and if there are any pits in these surfaces continue the grinding until a perfectly smooth surface is obtained on both the seat and the valve surface. If the original examination of the valves shows definite ridges or rings or if the edges of the valves are chipped, or if any pitting is very deep, replace the valve, grinding the replacement into its seat as described above. When a valve is fitted satisfactorily, check again to see that all valve grinding compound is removed. Any of this compound left in the mechanism will cause serious damage to the parts. After the cylinder head is replaced, the starting controls will have to be adjusted as described in section D-27.

i. ***Valves, Compression Relief*** — While the compression relief valves receive so little wear, due to the very short period the valve surfaces are exposed, it may be necessary to grind them. These valves should be examined whenever the cylinder heads are removed and if any grinding appears necessary the same procedure is to be followed as for the intake and exhaust valves. After the cylinder head has been replaced or if the valve control mechanism has been removed and then put back in place, it will be necessary to adjust the controls as covered in section D-27.

34. TIMING THE ENGINE

a. The crankshaft drives the engine camshaft through an idler gear and the injection pump camshaft also through an idler gear. The engine camshaft drives the magneto through an idler gear. All these gears must be properly meshed in order to have the engine correctly timed. These gears are all accessible after removing the oil pan, the radiator, the fan drive pulley, the front engine support and the front cover of the crankcase. The various gears are all marked to facilitate proper alignment of the teeth. The alignment is as follows:

(1) The punch mark on the camshaft gear which is the one stamped with a "C," must line up with the mark on the idler gear when the "S" mark on the idler gear matches the "S" mark on the crankshaft.

(2) With the idler gear in the above position, adjust the injection pump camshaft gear, stamped "P" so that the punch marks on this gear match up with the remaining punch marks on the above idler gear.

(3) The magneto idler gear and the magneto drive gear are punch marked so that the matching up of these marks gives the correct timing of the magneto.

35. STOPPING THE ENGINE

To stop engine proceed as follows:

(1) Remove the load.

(2) Make sure gasoline is turned *on* at the tank.

(3) Retard engine speed control lever and, at the same time, switch over to gasoline operation by throwing the compression release lever to its backward position.

(4) Let engine run on gasoline to burn out any accumulated oil that has gathered in the low-compression chambers.

(5) As soon as the engine is running on gasoline, *shut off* the gasoline supply at the tank and allow the engine to use up the gasoline in the carburetor.

(6) After engine stops, be sure to throw compression release lever over to the Diesel operating position, that is forward, to permit the starting valves to cool in their seats. This will reduce the likelihood of these valves warping.

36. ALTERNATOR AND EXCITER

a. ***Description***—The alternator and exciter have been described in section A — DESCRIPTION OF EQUIPMENT but, to facilitate reading, a brief description is given here also. The alternator is rated 50 KW, 62.5 KVA, 80% power factor, 1200

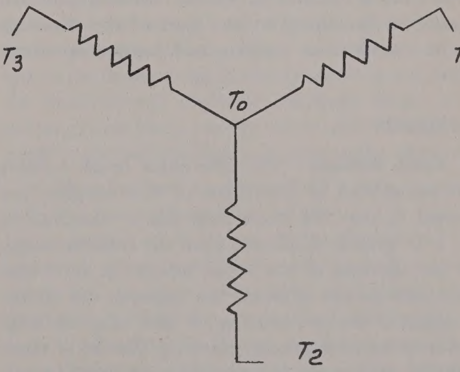


FIG. 24 — INTERNAL ALTERNATOR WIRING

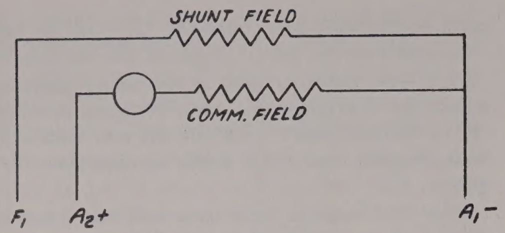


FIG. 25 — INTERNAL EXCITER WIRING

RPM, 240 volt, 3 phase, 60 cycle. It is designed for continuous operation and will operate at 25% overload for two hours. Amortisseur windings are provided for parallel operation. Internal alternator wiring is shown in fig. 24.

The exciter mounted above the alternator is shunt wound, rated 1.5 KW, 64 volt, and is "V" belt driven from the alternator shaft to run at 2000 RPM. Internal exciter wiring is shown in fig. 25.

b. ***Installation***—The frame of the alternator and the exciter are of drip-proof design which will protect the windings from falling water, etc., but if possible when installing the unit, select a normally dry location as excessive dampness may lower the insulation resistance of the windings. If a unit has been brought in from cold surroundings to a warm location the alternator and exciter should be kept covered with a tarpaulin or equivalent, until their temperature has risen to the temperature of the new location. This will prevent condensation on the windings and other parts. High potential tests of 1500 volts have been made on the alternator and exciter field windings and other windings have been tested at twice their normal voltage plus 1000 volts and no failure of insulation resistance is anticipated but every precaution against moisture on the windings should be exercised. In handling the unit during installation or movement use extreme care to see that the alternator or exciter windings are not damaged as an injury to any part of the windings may be sufficient to cause a coil burnout or short circuit.

37. BRUSHES

a. ***Brush Holders*** — The alternator brush holders when assembled at the plant of the supplier are mounted so that the lower edge has a clearance of from 1/16 inch to 3/32 inch from the collector rings. Also the location of the brush holders is such that the brushes do not override the edges of the collector rings and the two brushes on each ring are staggered in order to minimize grooving. Checks of these conditions are made before shipment of the completed unit. However, a periodic examination should be made to see that no loosening of holding devices has occurred which would alter the position of the brushes or allow any brush holder to touch the collector rings. Access to these parts is provided through openings in the frame of the alternator.

b. ***Radio Interference***—It is most important that any sparking of the brushes on the alternator collector rings or the exciter commutator be corrected as soon as possible as any such sparking may cause radio interference. A great deal of care has been used to eliminate radio interference and the generating units have passed the required tests at the plant of the supplier but all this care may be wasted if the alternator or exciter brushes are allowed to spark on the collector rings or the commutator.

c. ***Sparking of Brushes***—Under normal operating conditions and proper care of the brushes, collector rings or commutator, as the case may be, there should be no sparking of the brushes. The brushes are a homogeneous combination of carbon and graphite and are of a suitable grade for the alternator ring and exciter commutator material and for best results this same grade of brush material should always be used. If sparking occurs check the conditions listed below, references to rings, of course, applying to the alternator and references to commutator applying to the exciter. With few exceptions causes of sparking apply to both.

(1) *Brush Pressure* — If the pressure on the brushes is insufficient to make them follow the rings or commutator, the pressure should be increased by turning the bolt or pin about which the pressure spring is wound. Pressure on all brushes should be equal. An excessive pressure on one brush will cause it to take more than its share of the load. The brush pressure can be measured by using a spring balance reading the pounds pull necessary to just lift the brush off the ring or commutator as the case may be. The brush pressure should be 2 or 3 pounds per square inch of brush bearing surface.

(2) *Brush Holder Vibration*—Loose brush holders will cause sparking. The obvious remedy is to tighten them. As previously noted the lower edge of the brush holders should clear the rings or commutator by 1/16 inch to 3/32 inch. Also check to see that the yoke, which carries the brush holders, is tight.

(3) *Brush Chatter* — Examine the brush to see that it is not cracked or part of it broken off. See that the pressure spring is in position to apply pressure to the brush.

(4) *Oil Vapor*—Wipe off the rings or commutator with a dry lintless cloth, cleaning all adjacent parts thoroughly.

(5) *Bearing Surface of Brushes*—The curve of the bearing surface of the brushes should fit the curve of the rings or commutator. To obtain this fit use long strips of No. 4/0 sandpaper under the brush, holding the sandpaper in contact with the ring or commutator and moving it back and forth under the brush. CAUTION: **NEVER USE EMERY CLOTH OR ITS EQUIVALENT. USE SANDPAPER.** Clean all parts thoroughly after this operation. NOTE: The final finishing strokes of the sandpaper should be made in the direction of rotation of the rings or of the commutator, the brush being lifted for the return stroke. The alternator and exciter rotate in a clockwise direction when viewed from the radiator end of the entire unit.

(6) *Rough Collector Rings*—Slightly rough collector rings can be sanded down by following the procedure in No. 5 above, the sandpaper, of course, being reversed. The brushes should be lifted during this operation. If preferred a block of wood cut to the curve of the rings can be used to hold the sandpaper. If the roughness of the rings is excessive or if they are worn eccentric it will be necessary to remove the rotor and turn the rings down in a lathe.

(7) *Rough Commutator*—The procedure in No. 6 above applies also to the exciter commutator except that care must be taken to see that the mica strips between the commutator segments are undercut. A hack saw blade of the same thickness as the mica separators can be used. This operation must be done carefully and should be done before any sanding down of the copper segments.

(8) *Collector Ring and Commutator Surfaces*—These surfaces should always be clean and highly polished. Under normal conditions only occasional cleaning will be necessary. Clean with a clean, lintless cloth. A very small amount of fuel oil may be used on the cloth but in this event a final cleaning with a dry cloth must be made.

(9) *Brush Holder Yoke* — Before loosening or removing the brush holder yoke on the exciter be sure to note its position and mark its location with respect to some stationary part. There is a notch marked CW in the brush holder which, on practically all units, is set opposite a chisel mark on the bearing housing. However, on a few units it has been found advisable to shift this yoke slightly from these marked positions. It is important that no change is made in the position of the brush holder yoke.

(10) *Short Brushes*—If brushes are badly worn they should be replaced.

(11) *Brush Pigtail Connections*—See that these are all tight so that each brush will take its share of the load.

38. BEARINGS, ALTERNATOR AND EXCITER

a. *General*—The alternator and exciter run on ball bearings. The alternator is equipped with a ball bearing on the exciter end and runs on a piloted ball bearing in the flange or flywheel half of the coupling to the engine. The exciter runs on two ball bearings.

b. *Bearing Lubrication*—The ball bearings of the alternator and exciter are packed with enough grease for 8000 hours or two years of 12 hour daily service. It is not necessary to add grease to these bearings when the unit is first put in operation. However, during the first run the bearings should be inspected for quietness of operation and any undue heating. The results of this inspection should be satisfactory as all units have passed inspection and test before shipment. It is recommended that bearing housings be opened about once in every two years of operation to check the condition of bearings and grease. If grease deterioration has occurred or dirt gained entrance to the bearing housings, the bearings and housings should be thoroughly cleaned and new grease added. The grease used must be a mineral product of the highest grade. Under no conditions should ordinary cup grease or animal or vegetable grease be used. Animal and vegetable greases are likely to develop free acids and also become rancid. As the purpose of the lubrication of ball bearings is to protect the highly polished surfaces of the balls from corrosion as well as to lubricate, grease that might cause corrosion must not be used. When it is necessary to add additional grease to the bearings, as is evident from inspection, first clean all adjacent parts thoroughly with fuel oil or kerosene. This applies also to the pressure gun fittings and the drain plugs. Remove the drain plugs and free the drain plug holes of any hardened grease. Then add grease until grease begins to come out of the drain plug holes. Start the engine and run the alternator before replacing the drain plugs and run it until all excess grease is vented. Continued operation of the alternator for several minutes with the drain plug removed will insure that there is no pressure on the grease in the bearings. If this pressure is not relieved the bearings will probably overheat. Wipe off any excess grease being careful not to get it on the alternator or exciter windings and replace the drain plugs.

c. *Cleaning Ball Bearings*—Ball bearings are very sensitive to small amounts of dirt or grit and must be protected at all times. If bearings have to be removed, clean all adjacent parts and after removal cover the bearings with clean wrappings. Before mounting the bearings clean them thoroughly with carbon tetrachloride, being careful not to let this come in contact with any windings of the alternator or exciter.

d. ***Removal of Ball Bearings*** — In removing (or mounting) ball bearings pressure should be applied only against the inner race always using a sleeve or other intermediate piece if removal is accomplished by hammer blows. Cover the bearing carefully during this operation if there is any danger of flying particles getting in among the balls. Never attempt to remove or mount a ball bearing by exerting pressure against the outer race as if this is done the bearing may be seriously damaged. In driving the belt pulleys on the shaft of the alternator and the exciter the bearings must not be subjected to actual pressure, especially hammer blows. Any pressure of this kind should be taken up by supporting the opposite end of the shaft against a stop of some kind. After the bearings have been reinstalled grease them in accordance with section *b* above.

39. EXCITER BELTS

a. ***Care of Exciter Belts***—Tension of the two "V" belts which drive the exciter is regulated by the insertion or removal of shims underneath the exciter base. For best results the belts should be taut enough so that a reasonable pressure applied midway between the pulleys will not deflect the belt more than one inch. Never oil the belts. This not only reduces the belts' coefficient of friction, but also damages the rubber. Oil, grease or other harmful substances on the belts should be removed with naptha or soap and water. When it is necessary to replace belts, never replace one of the two belts which drive this exciter. Always install a complete new set. If only one belt is replaced, the new belt will carry more than its share of the load, thereby causing it to wear excessively. Never replace or remove belts by forcing them over the sheeves or pulleys. Always loosen the exciter hold-down bolts and tilt the exciter so that the belts may be easily removed or replaced. It will, of course, be necessary to remove the belt guard.

40. INSULATION RESISTANCE

a. ***Test for Insulation Resistance***—The insulation resistance of the windings of the stator and rotor of both the alternator and the exciter should be checked periodically. This can be done with the use of a megger. The insulation resistance of new machines should not measure less than one megohm and all machines have met this requirement during test at the plant of the supplier. The insulation resistance varies greatly in different machines but regular measurements on the same machine at the same temperature will detect any abnormal condition of the insulation and steps may be taken to remedy it before a failure occurs. Following is the test procedure to follow:

Test of Alternator Stator

Open the circuit breaker. Connect the megger to a stator lead. This may be done where either stator lead is connected to the switchboard. The other side of the megger must be connected to the ground.

Test of Alternator Rotor

Lift the brushes from the slip rings. Connect the megger between a slip ring and the ground.

Exciter Armature and Field

These are tested together by connecting the megger to terminal #3 or #4 on the terminal block and to the ground.

41. SWITCHGEAR

a. ***Description*** — The control cabinet and circuit breaker have been described in section A-11. These are shown in figs. 1 and 5 and a connection diagram is shown in fig. 7.

b. ***Operation***—The power unit should never be started under load, so, before starting, the air circuit breaker should be in the open position. This breaker is manually closed by the hand lever on the front of the breaker housing and when closed the handle is rotated clockwise as far as it will go and in this position a red disk appears in the opening near the handle. The breaker is manually tripped by pressing the release button, located below the handle, which also causes the red disk to shift and a green one to appear. The visible disk should be green when starting a unit. The opening of the circuit breaker, however, either automatically or manually, does not throw the control lever to its counterclockwise position. This lever must be thrown to this position *after* the breaker is opened. Do not try to open the circuit breaker by use of the control lever as it is not designed to be operated this way. With the unit running on Diesel cycle the voltage is adjusted automatically, by the voltage regulator, to normal value and the circuit breaker may then be closed connecting the unit to its load.

42. CIRCUIT BREAKER

a. ***Description***—The air circuit breaker (figs. 26 and 27) has an inverse time-delay device, a short circuit trip, over-current coils and an arc quencher.

b. ***Time Delay*** — The inverse time-delay device (fig. 28) prevents unnecessary interruptions on momentary overloads without altering the protection afforded in the event of short circuits or sustained overloads. This device is direct acting and mechanically connected with a link to the overload armature. The main parts consist of a dashpot, which contains a special oil to the depth marked

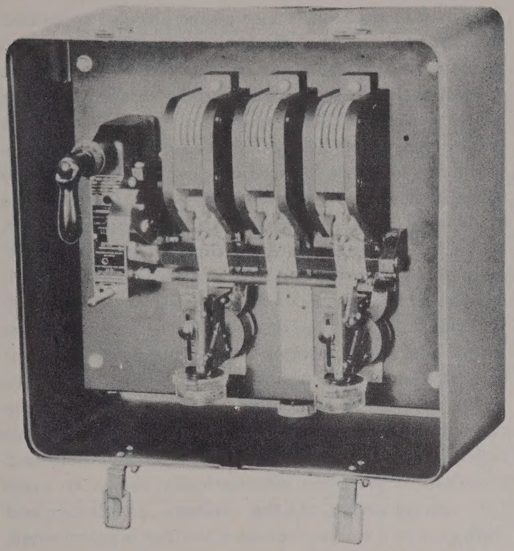


FIG. 26—CIRCUIT BREAKER WITHOUT COVER

"oil line" and a disk or plunger which is connected to the overload electro-magnet armature. The delay feature is obtained by the pull of the armature, due to overload, being resisted by the disk the movement of which in the cylinder is retarded by the oil. The delaying action continues until the disk has pulled away from the oil at which time the armature pull is not interfered with and it operates to open the breaker. If the overload is removed before the breaker is tripped the disk returns to the bottom of the cylinder and the breaker is not tripped.

c. ***Short Circuit Trip*** — The short circuit trip (fig. 26) forms a part of the inverse time-delay overcurrent trip. While the overcurrent trip is calibrated from normal to 200 percent of the current rating of the breaker, the short circuit trip is calibrated at approximately 10 times normal. When a short circuit occurs, the overcurrent armature lifts the entire oil dash-pot unit and trips the breaker instantaneously.

d. ***Series Overcurrent Coils***—These coils are surrounded by a magnet and armature. Current passing through the coils furnishes the necessary magnetizing force to cause the armature to trip the breaker, through the operation of the inverse time-delay device if the load is such that it can be handled safely for a short time, or through the short circuit trip which, under heavy overloads, acts instantaneously. On the front of the overcurrent unit is a plate marked with calibration points. The relative position of the index point and the calibration point is governed by a calibrating screw and adjusting nut, which also includes the indicator. By loosening the nut and moving the calibrating screw the calibration can be set for opening of the breaker on currents from 100 to 200 percent of the normal rating of the breaker. Moving the nut downward increases the current value at which the breaker will trip while moving the nut upward decreases the tripping value.

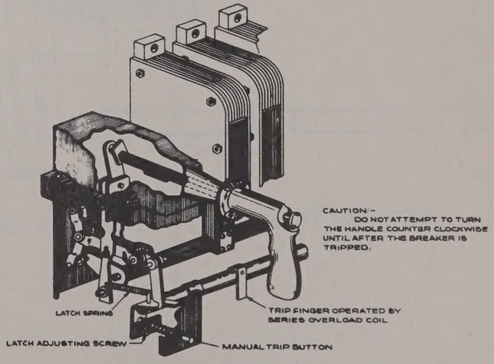
e. ***The Arc Quencher***—The arc quencher, which is included in the breaker assembly, is so designed that it does not require any adjustment whatsoever.

f. ***Disassembly*** — The progressive disassembly of the circuit breaker is shown in fig. 29.

43. VOLTAGE REGULATOR

a. ***General***—The voltage regulator, located in the control cabinet is a General Electric Company, Type GA37. This regulator automatically controls the output voltage of the alternator. It consists principally of a control electro-magnet, which receives its excitation from the alternator to be regulated; a variable resistance element operated by the electro-magnet through an intermediate lever mechanism; an adjusting weight and an air dashpot; a potential transformer and voltmeter for reading the output voltage and a current transformer and ammeter for reading the output load. Other equipment in the cabinet, as listed in section A-10, is an exciter field rheostat; a compensating rheostat for parallel operation of alternators; and a voltage adjusting rheostat. A connection diagram is shown in fig. 30.

b. ***Regulator In and Out of Service*** — The voltage regulator can be left permanently in the circuit when starting up and shutting down the generating unit. When the engine, and therefore the alternator,



CAUTION:-
DO NOT ATTEMPT TO TURN THE HANDLE COUNTER CLOCKWISE UNTIL AFTER THE BREAKER IS TRIPPED.

FIG. 27 — CIRCUIT BREAKER MECHANISM

comes up to speed the regulator will automatically take control and adjust the voltage to the required value. If for any reason it is desired to remove the regulator from service, turn the field rheostat toward the "IN" position and short circuit the leads connected to terminals 7 and 8 on the control unit terminal board which is located to the right and top of the assembly. With the regulator out of service it will be necessary to control the alternator voltage manually with the exciter field rheostat. To use this rheostat the control cabinet cover will have to be left off as the control knob does not project through the cabinet cover.

c. ***Resistance Element***—This element is connected in series with the exciter field and it is through the control of this field by automatically varying this series resistance that the regulator controls the alternator voltage. The component parts of the voltage regulator are shown in fig. 31. Fig. 32 shows the construction detail of the resistance unit. The resistance element is composed of two stacks, No. 7 in fig. 31, of special resistance plates separated near the center by metal spacers. Small fins, extending from the top and bottom of these spacers, fit into slots cut in the edges of the resistance plates, locking them in position. These plates are also separated at the back of the stacking by additional metal spacers, and in the front end of each plate a silver button is inserted which is slightly thicker than the plate itself. The center spacers are thicker than the others and therefore the resistance stacking or element can be tilted forward and backward. When the stack is tilted in the backward position, the resistance plates and metal spacers form a high resistance path and when the stack is tilted forward the silver buttons come together forming a metal to metal path of negligible resistance. Varying degrees of this tilting produce varying degrees of resistance of the stack. The tilting motion of the resistance element is obtained by the action of the lever mechanism which in turn is controlled by the position of the core of the control magnet. As previously noted this resistance unit is in series with the exciter field and this field is therefore automatically varied to meet the requirements of the voltage regulator and through this a stable alternator voltage is maintained.

d. ***Adjusting Weight***—The voltage regulator can be adjusted to obtain the correct voltage by shifting the adjusting weight (28) in fig. 31. Moving this weight to the left lowers the voltage and moving it

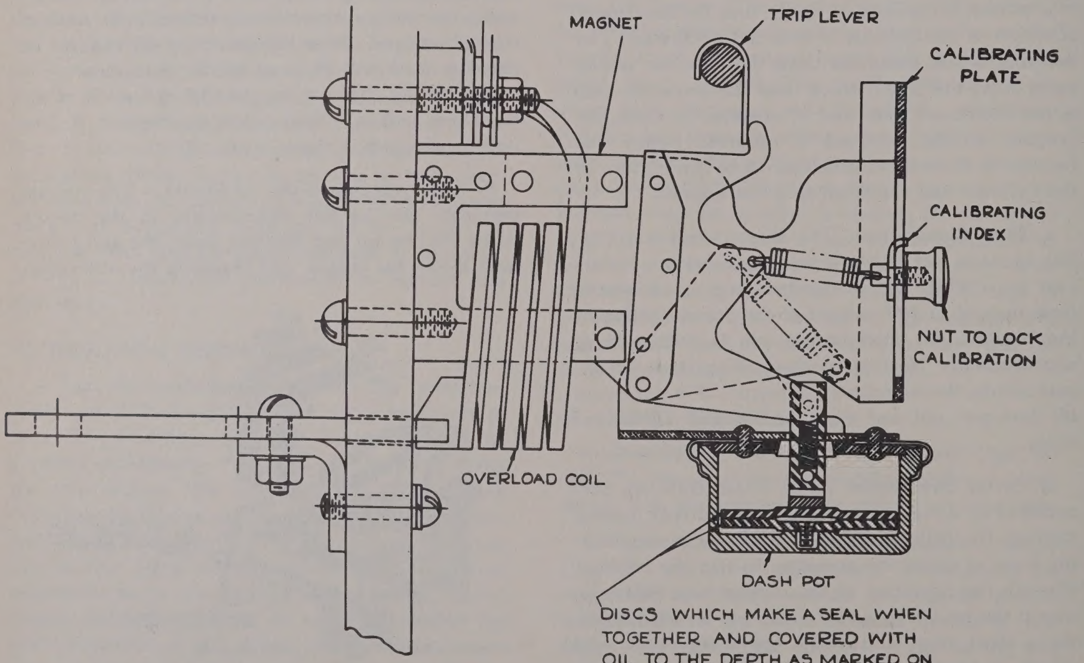
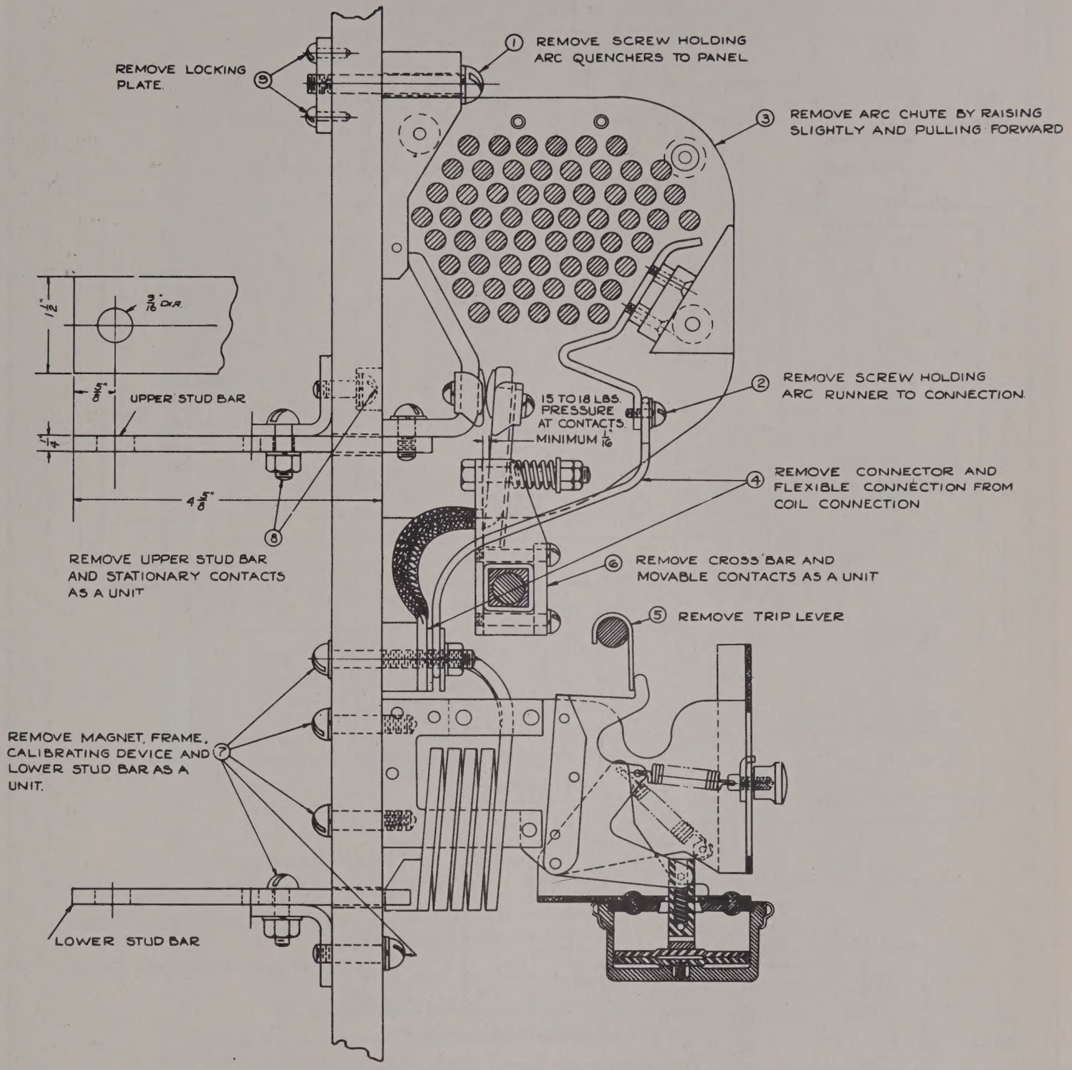

MAGNET
TRIP LEVER
CALIBRATING PLATE
CALIBRATING INDEX
NUT TO LOCK CALIBRATION
OVERLOAD COIL
DASH POT
DISCS WHICH MAKE A SEAL WHEN TOGETHER AND COVERED WITH OIL TO THE DEPTH AS MARKED ON DASH POT.

FIG. 28 — CIRCUIT BREAKER TIME DELAY DEVICE AND SHORT CIRCUIT TRIP


① REMOVE SCREW HOLDING ARC QUENCHERS TO PANEL
REMOVE LOCKING PLATE. ⑨
③ REMOVE ARC CHUTE BY RAISING SLIGHTLY AND PULLING FORWARD
1 1/2"
3/16" DIA.
5/16"
UPPER STUD BAR
1/4"
4 5/8"
15 TO 18 LBS. PRESSURE AT CONTACTS.
MINIMUM 1/16
② REMOVE SCREW HOLDING ARC RUNNER TO CONNECTION.
④ REMOVE CONNECTOR AND FLEXIBLE CONNECTION FROM COIL CONNECTION
⑧
REMOVE UPPER STUD BAR AND STATIONARY CONTACTS AS A UNIT
⑥ REMOVE CROSS BAR AND MOVABLE CONTACTS AS A UNIT
⑤ REMOVE TRIP LEVER
REMOVE MAGNET, FRAME, CALIBRATING DEVICE AND LOWER STUD BAR AS A UNIT. ⑦
LOWER STUD BAR

REASSEMBLE IN OPPOSITE SEQUENCE

PROGRESSIVE DISMANTLING AND REASSEMBLY INSTRUCTIONS

FIG. 29 — PROGRESSIVE DISMANTLING AND REASSEMBLY OF CIRCUIT BREAKER

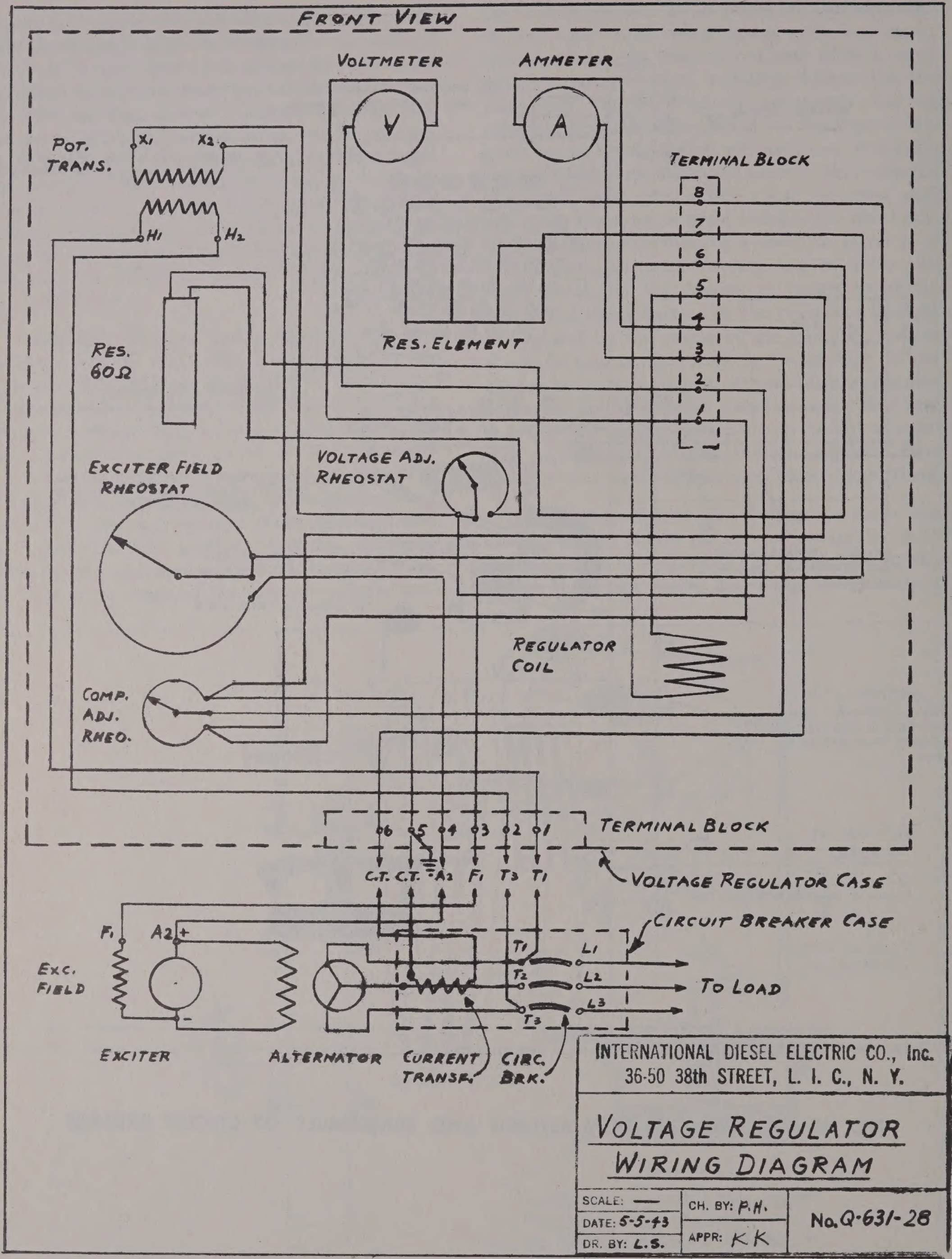

FRONT VIEW
VOLTMETER
AMMETER
V
A
POT. TRANS.
X1
X2
H1
H2
TERMINAL BLOCK
8
7
6
5
4
3
2
1
RES. ELEMENT
RES. 60Ω
EXCITER FIELD RHEOSTAT
VOLTAGE ADJ. RHEOSTAT
REGULATOR COIL
COMP. ADJ. RHEO.
6
5
4
3
2
1
TERMINAL BLOCK
C.T.
C.T.
A2
F1
T3
T1
VOLTAGE REGULATOR CASE
CIRCUIT BREAKER CASE
F1
A2
+
-
EXC. FIELD
T1
T2
T3
L1
L2
L3
TO LOAD
EXCITER
ALTERNATOR
CURRENT TRANSF.
CIRC. BRK.
INTERNATIONAL DIESEL ELECTRIC CO., Inc.
36-50 38th STREET, L. I. C., N. Y.
VOLTAGE REGULATOR
WIRING DIAGRAM
SCALE: —
DATE: 5-5-43
DR. BY: L.S.
CH. BY: P.H.
APPR: KK
No. Q-631-28

FIG. 30 — VOLTAGE REGULATOR WIRING DIAGRAM

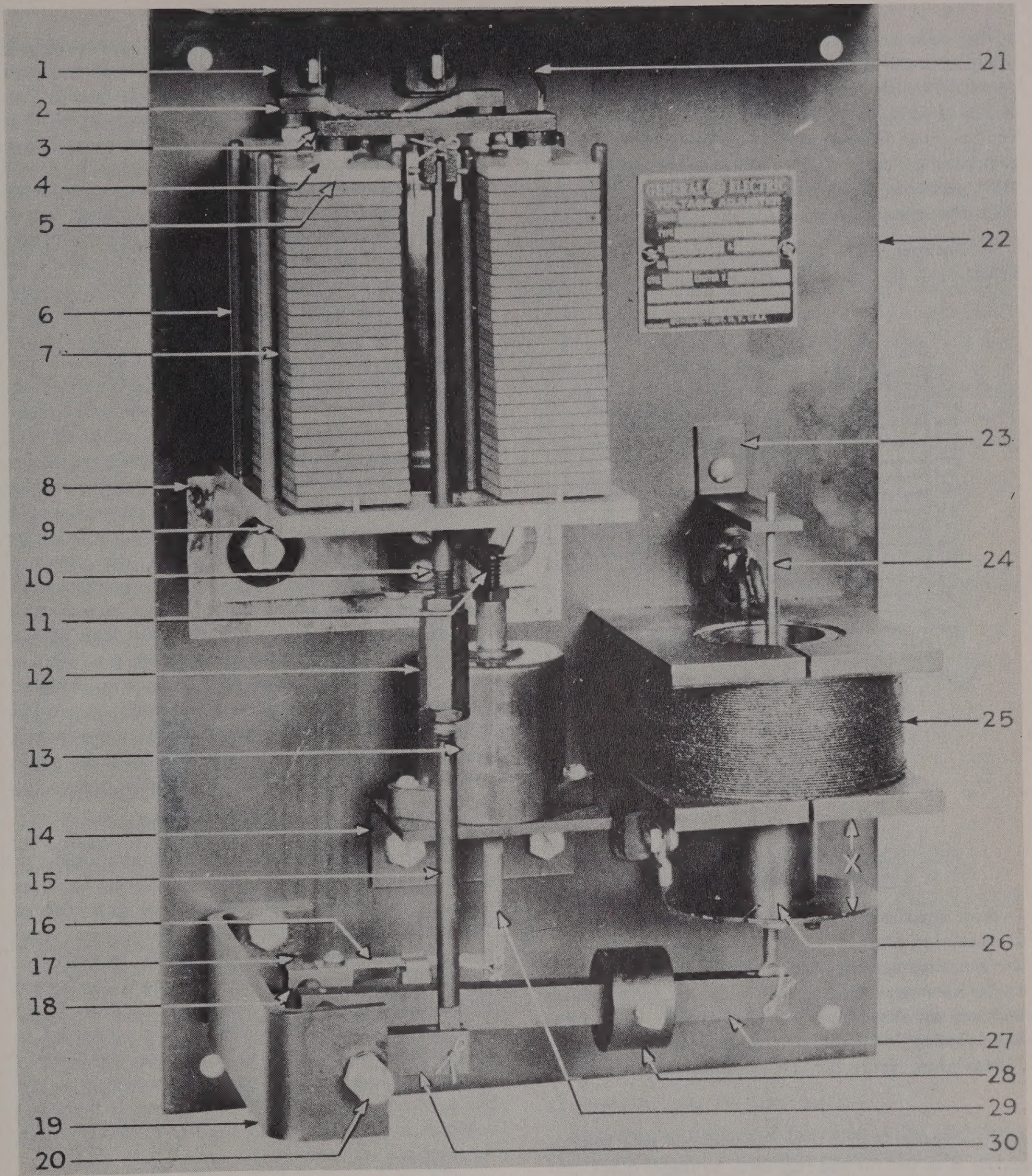

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
X
GENERAL ELECTRIC

FIG. 31 — VOLTAGE REGULATOR COMPONENT PARTS

1—Binding post
2—Rear equalizer bar
3—Front equalizer bar
4—Insulating button
5—Retaining plate
6—Insulated guide rod
7—Resistance plate
8—Insulating spacer
9—Supporting plate
10—Connecting rod
11—Dashpot adjusting screw
12—Adjusting nut
13—Air dashpot
14—Dashpot support
15—Connecting rod
16—Flat steel spring
17—Pivot
18—Dashpot lever
19—Support
20—Pivot bearing
21—Flexible connection
22—Base
23—Guide for core stem
24—Core stem
25—Main control magnet
26—A-C core
27—Main operating lever
28—Adjusting weight
29—Dashpot guide lever
30—Lever for operating rod

to the right raises the voltage. Before changing the position of the weight the voltage adjusting rheostat, located directly under the meters, should be set in the *mid-position.* While adjusting this weight the control may be temporarily taken away from the regulator by turning the field rheostat towards the "IN" position. This procedure should be repeated until the regulator maintains the correct voltage.

e. *Dashpot* — The air dashpot (13) in fig. 31 is attached to the operating mechanism through a flat flexible spring (16). The function of this flexible spring is to permit the regulator to make quick corrections in voltage for load changes with a minimum number of oscillations of the magnet core and lever mechanism. The factory setting of this spring will usually be found to be satisfactory. However, the effect of this spring can be varied by an adjustable stop or spacer. Moving this spacer to the left increases the flexibility of the spring while moving it to the right decreases its flexibility. The action of the dashpot is controlled by an adjusting screw (11) in fig. 31, by which a small port-hole in the top of the dashpot may be gradually opened or closed. Turning this screw to the right closes the port-hole. The action of the dashpot should be as free as possible, the port-hole being closed sufficiently to prevent continuous hunting of the regulator mechanism.

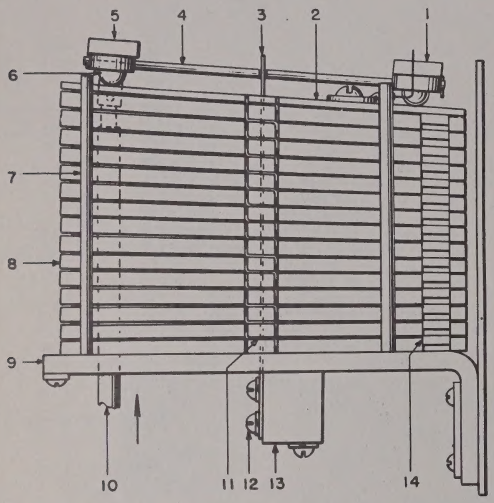


FIG. 32 — VOLTAGE REGULATOR CONSTRUCTION DETAIL

1—Rear equalizer bar
2—Retaining plate
3—Actuating spring
4—Connecting rod
5—Front equalizer bar
6—Insulating button
7—Insulating guide rod
8—Resistance plate
9—Supporting plate
10—Connecting rod
11—Center metal spacer
12—Screw
13—Supporting block
14—Rear metal spacer

f. *Cross Current Compensation*—The current transformer located in the circuit breaker cabinet, serves as an ammeter transformer and also, in conjunction with the compensating rheostat, located in the control cabinet, it operates to prevent reactive circulating current between alternators when two or more are operated in parallel. The primary of the current transformer is connected in the lead opposite the two to which the potential transformer is connected. See fig. 30. If for any reason the current transformer is disconnected care should be taken to tag *all* connections so that they can be reconnected exactly as they were. The compensating rheostat is adjusted at the plant of the supplier and the adjustment should not be changed unless excessive cross currents occur during parallel operation. Turning this rheostat counter-clockwise will increase the effectiveness of the compensating action but will also increase the voltage drop between no load and full load with a lagging power factor load. It is necessary to remove the control cabinet cover to operate this rheostat.

When the excitation of units operating in parallel has been adjusted, the cross current compensating feature of the voltage regulator will maintain equal division of wattless current between the units.

g. *Checking Unsatisfactory Operation*—

(1) *Erratic Voltage* — If the regulator holds an erratic or unstable voltage, check all wiring for loose or faulty connections. See that there is no friction or binding in any of the mechanical joints of the regulator. See that there is no friction in the regulator resistance stacking and that it tilts easily backward with rod (10), fig. 31, in the raised position. Make sure that the indicating voltmeter is connected to the same phase as that to which the regulator is connected, and that the two are connected to the bus as closely as possible to each other. If there is a continuous pulsation of the regulated voltage check the dashpot adjustment.

(2) *Voltage Does Not Build Up*—If the voltage fails to build up, check the exciter field rheostat setting. Make sure that the resistance element of the regulator is connected in circuit and that all the silver contact buttons are making contact when the main magnet core is in the extreme lower position. Check adjustment of rod (10), fig. 31. See section on CONNECTING RODS.

(3) *High Voltage*—In case of high voltage see that there is no short circuit in leads coming from

the regulator resistance element or an open circuit in the control rheostat, resistor or electro-magnet circuit. Check the exciter field rheostat setting. See that the resistance element tilts backward when the main magnet core is in the extreme raised position. Check adjustment of rods (10) and (15), fig. 31. See section on CONNECTING RODS.

(4) *Rising Voltage*—If the voltage rises upon an increase in load, reverse the leads on lower terminal block—5 and 6 and also reverse leads from current transformer—5 and 6. If the voltage drops excessively upon an increase in load, lower the core stem (24) slightly.

Note: NO OIL OR GREASE SHOULD BE PLACED ON ANY PART OF THIS REGULATOR.

h. *Internal Adjustments of Regulator*—All regulators are adjusted and tested before leaving the factory and should require no further adjustment. However, should the regulator get out of adjustment or if it is found necessary to install new parts, the following instructions should be observed and understood before attempting any readjustment. Before making any of the following adjustments, take control away from the regulator, open the potential circuit, and short-circuit the regulator stacks at terminal points 7 and 8 as described in section PLACING REGULATOR IN AND OUT OF SERVICE. Otherwise, make the following adjustments with the alternator and exciter out of service.

(1) *Resistance Element*—For proper assembly of the resistor element see figs. 32 and 33. The resistance plates should be stacked one above the other with the silver buttons towards the front and with the metal spacers (11) and (14) between each adjoining plate. Care should be taken not to bend or distort these plates, and they should fit properly into the slots intended for them in the edges of the resistance plates. There should be approximately twenty-seven plates in each stack, and at the top of each stack there should be placed the metal plate to which is attached the flexible connections from the two binding posts at the top of the regulator.

(2) *Retaining Spring*—The function of spring (3), fig. 32, is to insure a backward tilt (high-resistance position) to the resistance element when pressure is released from the front or when rod (10) is in the raised position. This spring has a slight bend and it should be fastened to support (13) so that it is inclined towards the rear. In adjusting it in the "V" groove upon rod (4), see that it exerts no downward pressure upon the resistance stacking. There should be a slight clearance between the top side of the hole in the spring and the bottom of the "V" groove.

(3) *Lever Arms and Pivots*—Lever arms (18), (27) and (30), fig. 31, are rigidly pinned in their proper respective locations to pivot (17). Pivot bearing (20) should be adjusted so that there is a slight end play to pivot (17).

(4) *Main Magnet Core*—With lever (27), fig. 31, held in the horizontal position, core (26) should be adjusted on core stem (24) so that the distance "X" between the top of the core flange and the under side of the spool body is approximately ¾ to ⅞ inch. Increasing the distance "X" gives closer voltage regulation but decreases the stability of the regulator.

(5) *Connecting Rods*—Connecting rods (10) and (15), fig. 31, should now be adjusted by means of adjusting nut (12) until the bar is in a horizontal position. In this position the resistance element should be tilted completely forward with the silver buttons permanently in contact; that is, the resistance stacking, by means of insulating button (4) and connecting rods (10) and (15), should be supporting the combined weights of lever (27), adjusting weight (28), and core (26).

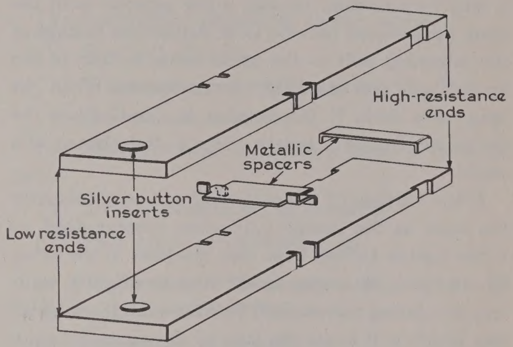


FIG. 33 — RESISTANCE PLATES AND METAL SPACERS FOR VOLTAGE REGULATOR

44. SINGLE UNIT OPERATION

a. *Voltage Adjustment for Load*—After the power unit is set up and connected to the load the circuit breaker being open, the engine should be started and thrown over to the Diesel cycle but before closing the circuit breaker the speed should be adjusted so that the voltmeter reads about 242 volts. After the circuit breaker is closed the speed of the engine should be adjusted so that the alternator voltage is 240. If the load is located at remote points the voltage of the alternator may be held at a value higher than 240 to compensate for line drop so that the voltage at the load will be 240.

45. PARALLEL OPERATION

a. *Connections*—When two or more units are to be operated in parallel interconnecting cables must be connected to corresponding lower or load terminals of the circuit breakers of the units.

b. *Operation*—To parallel a second unit with one which is carrying a load, bring the second unit up to speed by adjusting the voltage to about 240 by means of the voltage adjusting rheostat and close the synchronizing switch. The synchronizing lamps will flash on and off at a frequency dependent upon the difference in speed of the two units. As a rule the speed of the incoming unit will be higher than that of the one carrying the load and its speed must be reduced by moving the control lever on the engine until the lamps fluctuate from light to dark about once every one or two seconds. After making a speed adjustment it may be necessary to wait a few seconds until the lamp fluctuations become slow. Adjust the voltage of the incoming unit to the same value as that of the loaded unit and close the circuit breaker when the lamps are dark. If the breaker is closed when the lamps are bright a severe voltage disturbance will result.

If the voltage of the incoming unit is not exactly the same as the loaded unit when synchronized, or if the load is shifted from one machine to the other by changing the engine speed after paralleling, wattless circulating current will flow between the alternators which will cause the sum of the ammeter readings to be higher than the total current taken by the load. After the load has been divided equally between the units the following check should be made:

Turn the voltage adjusting rheostat of one unit counter-clockwise. If the current shown by the load ammeter starts to increase, turn the rheostat clockwise. Continue adjustment until the sum of the ammeter readings of the two units is a minimum. After this adjustment has been made the voltage adjusting rheostats of both units should be adjusted simultaneously to bring the line voltage to the desired value.

Once the excitation of the units has been adjusted the cross current compensating feature of the voltage regulator will maintain equal division of wattless current between the units.

A more stable output of alternators operating in parallel can be obtained by adjusting the compensating rheostat but this will be accompanied by a greater droop.

If a third unit is to be parallel the same procedure should be followed as described for a second machine.

46. SUGGESTIONS FOR OVERCOMING TROUBLE

a. *Failure to Start on Gasoline*—

(1) No gasoline in carburetor.

(2) Gasoline supply cock closed.

(3) Carburetor choked too much, resulting in flooding.

(4) No spark from magneto.

(5) Compression release lever in Diesel position.

(6) Condensation on spark plugs.

(7) Weak storage batteries will not turn engine over rapidly enough to start.

b. *Missing and Backfiring*—

(1) Water in gasoline.

(2) Air leaks around intake manifold.

(3) Starting valves not properly seated.

(4) Valves sticking. Apply mixture of ½ kerosene and ½ lubricating oil to valve stems.

(5) Too close a clearance of valve, preventing valves closing completely.

(6) Sticking Injector plunger. Probably due to uneven tension of hold-down bolts distorting pump body. Loosen bolts slightly.

(7) Fuel oil pressure low. Check the filters. Check primary pump by disconnecting piping from upper outlet and substituting a pressure gage. The pressure should be about 35 pounds.

c. *Puffs of Smoke*—

(1) Air leak in suction line admitting air into the fuel line.

(2) Dirty fuel oil strainer or poor connections.

(3) Single puffs of smoke at regular intervals would indicate sticking valves or too close a valve clearance in one cylinder.

d. *Locating Weak Cylinder*—Disconnect the fuel line to the injection nozzles one at a time thus preventing fuel being delivered to the disconnected cylinder. If the cylinder being tested is firing correctly the engine will slow down perceptibly. When the cylinder that is at fault is disconnected there will be no perceptible slowing down of the engine. A weak cylinder can be traced to the following:

(1) Leaking or sticking intake or exhaust valves.

(2) Low compression caused by stuck piston rings or leaking valves.

e. *Engine Knocking*—

(1) Overload.

(2) Dirty injection nozzles.

(3) Air in fuel line.

(4) Loose piston pin, connecting rod or crankshaft bearings. Loose coupling to alternator.

(5) Piston slap due to worn pistons or cylinder walls.

(6) Combustion knock. Usually in one or two cylinders indicates leaky injection nozzle.

(7) Generally rough running usually due to improper timing of injection.

(8) Poor grade of fuel oil or water in fuel oil. Use only fuel oil that agrees with the specifications.

(9) Excessive carbon in cylinders.

f. *Dilution of Lubricating Oil in Crankcase*—

(1) Stuck piston rings.

(2) Overload. More fuel oil injected than will burn in air present.

(3) Low operating temperature.

(4) Worn pistons or cylinder sleeves.

(5) Leaky injector connections.

g. *Excessive Lubricating Oil Consumption*—

(1) Oil leaks.

(2) Piston pumps oil.

(3) Poor grade of oil used.

(4) Piston rings stuck in grooves.

(5) Leaky cylinder head gasket.

h. *Low Lubricating Oil Pressure*—

(1) Insufficient amount of oil in crankcase.

(2) Dirt under pressure regulating valve.

(3) Oil pump strainer clogged or pump not working.

(4) Broken oil pressure indicator or pipe lines.

(5) Loose bearings.

(6) Loose oil line connections.

(7) Worn camshaft bushings.

i. *Low Fuel Oil Pressure*—

(1) Fuel oil too light or too thin. Use oil that agrees with the specifications.

(2) Air leaks in intake fuel line.

(3) Auxiliary fuel oil filter stopped up.

(4) Wear in transfer pump.

j. *Failure to Change Over to Diesel Operation*—

(1) Starting valve mechanism sticks.

(2) Injection pump not primed. Vent air from system.

(3) Fuel oil supply cock closed.

(4) Speed control lever not set in proper position.

(5) Transfer pump not developing pressure.

(6) Trigger or safety control device not set.

k. *Engine Smoking*—If dark black smoke is present it is caused by:

(1) Dirty spray nozzles.

(2) Valves leaking or set too close or with too much clearance.

(3) Overloaded; injection of fuel too early.

(4) Lack of compression.

(5) Poor grade of fuel oil.

(6) Engine overloaded causing excess fuel oil.

(7) Air in fuel system.

(8) Air filter clogged up.

l. *Engine Overheating*—

(1) Insufficient amount of cooling water.

(2) Fan belt slipping.

(3) Water pump not working properly.

(4) Excess load on engine.

(5) Sludge or lime formation in radiator or water jacket.

(6) Lack of lubricating oil pressure.

(7) Poor grade of lubricating oil.

m. *If Engine Stops*—The engine will not stop ordinarily except for lack of fuel.

(1) Check fuel oil pressure.

(2) Check lubricating oil pressure. Lack of oil will cause a bearing to seize and stop the engine.

(3) Crank engine by hand to determine if moving parts are free.

(4) Frozen water in fuel lines will stop flow of fuel.

(5) Safety device shut down engine. Cannot be put back into service until condition which caused them to operate is rectified.

(6) Auxiliary fuel oil filter clogged.

n. *Lack of Compression*—

(1) Sticky, dirty, pitted or improperly adjusted valves.

(2) Stuck, worn or broken piston rings.

(3) Leaky cylinder head gasket.

(4) Leaky gasoline starting valves.

o. *Lack of Power*—

(1) Injection pump air bound.

(2) Spray nozzles stopped up.

(3) Leaky valves or incorrect adjustment of valves.

(4) Insufficient fuel; auxiliary filter clogged up; supply or transfer pump not working properly.

(5) Air filter clogged up.

(6) Insufficient lubrication.

(7) Poor grade of lubricating oil.

(8) Silencer or exhaust pipe clogged up.

(9) Stuck piston rings or worn cylinders.

p. ***Avoiding Sludge and Dilution—***

(1) Avoid idling for long periods.

(2) Change lubricating oil as recommended.

(3) Use only a good grade of lubricating oil.

(4) When changing lubricating oil flush the crankcase with kerosene, flushing oil or fuel oil.

(5) Do not overload the engine.

(6) Do not run the engine with a dark smoky exhaust.

(7) Keep spray nozzles clean.

(8) Use fuel oil that agrees with the specifications.

(9) Piston rings must be free. Stuck rings permit blow-by and dilution.

(10) Change lubricating filter element as recommended.

(11) Do not operate engine at a low temperature.

q. ***Things That Must Be Done Periodically—***

(1) Examine valve rocker arms to see if being properly lubricated.

(2) Clean all screens.

(3) A small amount of kerosene applied to valve stems will prevent them from sticking.

(4) Examine all bearings occasionally and keep them tight.

(5) Examine engine for water, fuel oil and lubricating oil leaks.

(6) Clean or replace filter elements according to schedule.

(7) Grind valves. Do this only when absolutely necessary.

r. ***Switchgear Inspection—***

(1) In order to obtain satisfactory operation from this equipment it must have adequate care and periodical and intelligent inspection of all the devices and connections. When making such inspections, extreme care must be exercised that no circuits are shorted or grounded and that the inspector experiences no personal harm. Any defect that is discovered should be corrected immediately.

(2) Although a thorough examination and operational test has been made for all the equipment before leaving the plant of the supplier, a check should be made, after installation but before putting into service, of all connections, joints and instrument holding bolts to see that they have not become loosened or damaged during shipment.

(3) In general, very little maintenance is required other than keeping the equipment clean. No lubrication of any part is necessary except when specified. Due to the delicate construction of the switchgear, it is not recommended that major repairs be made in the field.

s. ***Voltage Regulator Not Working***—Look for:

(1) Open circuit due to
    (a) Exciter connections open.
    (b) Circuit open between exciter field and regulating resistance.

(2) Exciter field rheostat not at or near all out position.

(3) Short-circuit across terminals of regulator.

(4) Obstruction in air gap of regulator magnetic circuit.

t. ***Sparking at Silver Buttons of Voltage Regulator—***

(1) Excessive dirt or dust between buttons.

(2) Open circuit or poor connection between silver buttons and the regulating resistance.

(3) Open circuit in regulating resistance.

u. ***A.C. Voltage Erratic—***

(1) Loose or poor connections.

(2) See that there is no friction or binding in any of the mechanical joints of the regulator.

(3) See that resistance stacking tilts easily.

(4) Make sure that indicating voltmeter is connected to same phase as that to which the regulator is connected.

v. ***A.C. Voltage Droops Badly Under Load—***

(1) Exciter speed below normal.

(2) Exciter field rheostat turned too far towards "LOWER."

(3) Compensating rheostat too far in counterclockwise direction.

w. ***Circuit Breaker—***

(1) The safety and proper functioning of the connected apparatus depends upon the proper func-

tioning of the circuit breaker. Therefore the circuit breaker must have regular and careful inspection. Such inspection must be made while the engine is stopped and no power is on the switchboard. When making these inspections give special attention to the following features:

(a) Clean the mechanism thoroughly.

(b) Check the operating mechanism.

(c) Examine the dashpots to see if oil is at the proper level and in good condition.

(d) See that all bolts, nuts, etc., are tight.

(e) Check the relay operating the shunt trip device. If it is not in satisfactory condition replace it.

x. *Alternator and Exciter—*

(1) The main thing to guard against on the alternator and exciter is sparking of the brushes. Aside from the poor practice of letting this continue, it may produce radio interference. Stop any such sparking by cleaning the slip rings on the alternator and the commutator on the exciter as soon as possible, installing and fitting new brushes if necessary. Check as follows:

(a) Brush pressure. This should be sufficient to hold the brushes on the slip rings or on the commutator.

(b) See that brush holders are tight.

(c) See that the slip rings and the commutator have smooth, polished surfaces.

(2) Examine the bearings of both the alternator and exciter after a period of operation to determine if they are overheating.

47. STORING POWER UNITS

a. *Procedure*—When a power unit is not to be used for thirty days or more it should be stored in a dry and protected place. The following procedure should be followed. The lubrication precautions should be repeated every six months thereafter.

(1) Wash or clean and completely lubricate the engine.

(2) Drain the lubricating oil from the injection pump and governor and refill with new oil.

(3) Drain fuel oil from the fuel oil filter. Disconnect the fuel oil storage tank line at the inlet side of the primary pump and also disconnect the fuel oil return pipe at the injection pump. Connect a suitable tubing to the inlet side of the primary pump and lead the free end of this tubing into a container of flushing oil.

Recommended flushing oils:

Gulf Oil Corporation No. 301,
Shell Latus No. 22 Oil,
Formula No. 11326 Standard Oil Company,
No. 8504 or E382 Socony Vacuum Oil Co.,
Capella Oil AA.

(In emergencies a flushing oil mixture of ½ kerosene and ½ good grade of light lubricating oil may be used.)

Start and run the engine on gasoline until sufficient fuel oil has been used to assure filling the fuel filter and flushing the lubricating oil from the injection pump reservoir. About two quarts of oil will be required. The filling of the fuel oil filter can be determined by opening the air vent on the top of the filter. After this filter has been filled the gasoline operation of the engine should be continued for five minutes to assure the flushing of the internal parts of the injection pump. Then drain the flushing oil from the filter and reconnect the fuel line from the storage tank and the fuel return pipe at the injection pump.

(4) Drain water from the cooling system.

(5) Remove spark plugs and put the compression release lever in the gasoline (starting) position. Pour one tablespoonful of SAE-50 lubricating oil of good grade through spark plug opening into each cylinder. Put the compression release lever in the Diesel position.

(6) Remove valve housing cover and spray oil over rocker arm and starting valve assembly. Replace cover.

(7) If the exhaust system has been dismantled, cover the manifold opening carefully. If not dismantled, cover the exhaust pipe opening to prevent moisture from entering the manifold.

(8) Remove the oil filter element. (If any evidence of rust is found on the center stud, clean thoroughly.) Replace filter element and drain out any sludge from filter base.

(9) *The engine must not be run after the flushing operation.*

(10) Apply a complete but thin coating of Light Rust Preventative Compound per U. S. Army specifications No. 2-84, or equivalent, to all exposed unpainted parts such as threads and nuts, silencer and exhaust piping. Use a brush to apply the compound, being careful not to wet any rubber parts.

(11) Remove the storage batteries and check each cell for the charged condition. If the batteries do not show a full charge, have them charged. If the unit is to be stored for not over 60 days, it will be satisfactory to leave the electrolyte in the batteries

but after 30 days their condition should be checked again and a charge applied if necessary. If the storage period is to be longer than 60 days, the electrolyte should be drained out of the batteries and each cell rinsed out with water. Preserve the electrolyte in glass or crockery containers, *not metal*. If the electrolyte is not drained out due to the 60 day maximum storage period, the batteries should be stored where the temperature is not below 32°F. (0°—C.). If the batteries have been drained, they may be stored at any temperature.

48. PREPARATION FOR SERVICE AFTER STORAGE

a. ***Procedure***—To restore units to service proceed as follows:

(1) Remove the spark plugs and put the compression release lever in the gasoline (starting) position, and pour a mixture of one-half gasoline and one-half grade SAE-10, lubricating oil into each cylinder (two tablespoonfuls per cylinder is enough).

(2) Remove the valve housing cover and flush the valve and the valve operating mechanism with same mixture.

(3) Crank the engine rapidly until the excess oil has been blown out of the spark plug holes. This operation will loosen any tight piston rings and wash the old gummy oil from the valves and the pistons.

(4) Flush out the crankcase with kerosene and fill it with the specified grade of lubricating oil. (See "Lubrication chart.")

(5) Drain the oil from the injection pump and refill the pump to the proper level with the specified grade of lubricating oil.

(6) Be sure the filter has a new element before starting the engine.

(7) Remove all coverings from exhaust pipe openings.

(8) Install the spark plugs.

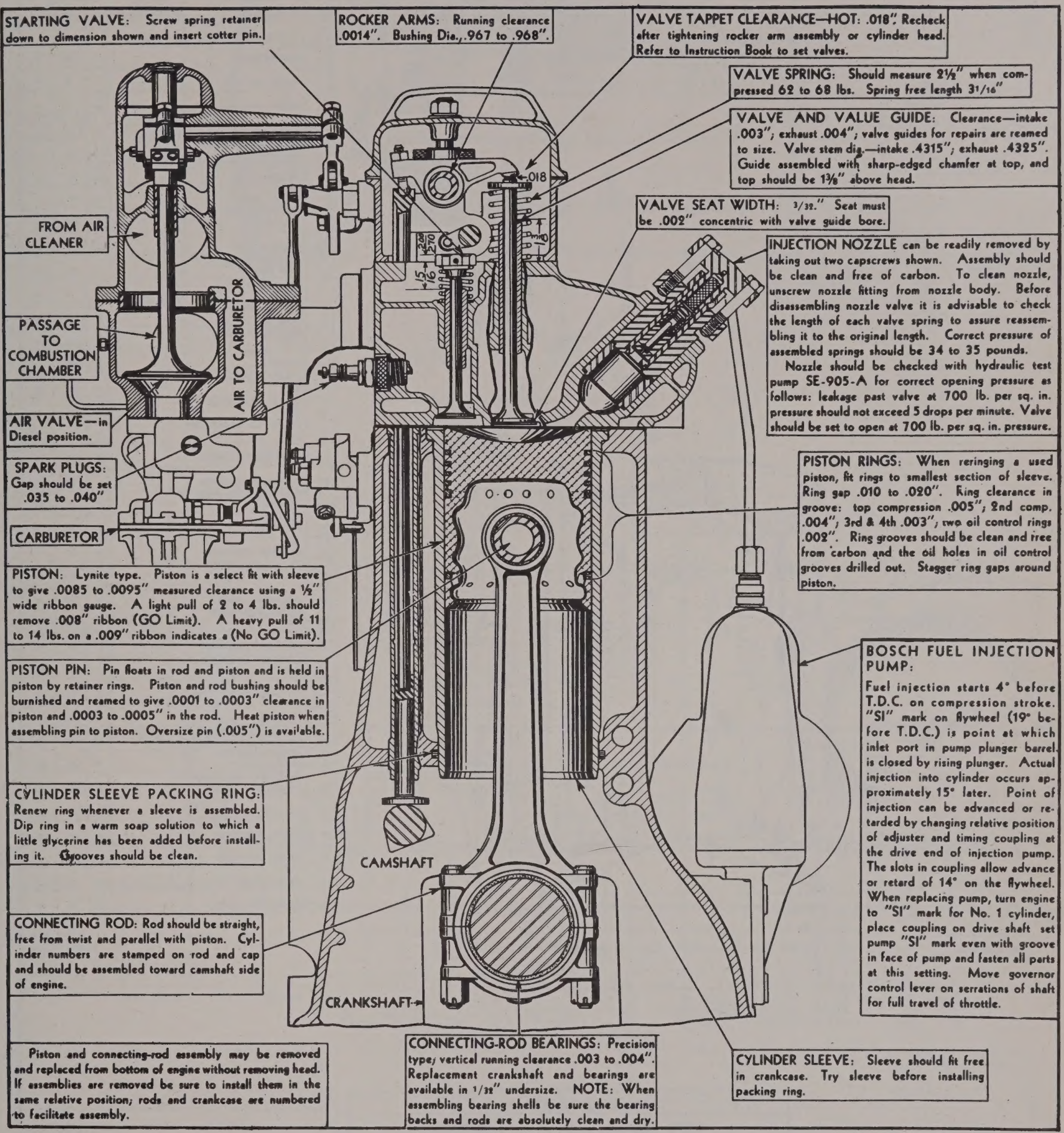
(9) Fill the water cooling system.

(10) Fill the fuel tanks.

(11) Start the engine and let it run slowly. Observe if any valves are sticking. If so, pour a small quantity of fuel oil or kerosene on the valve stems until the valves become loose.

(12) Assemble the valve housing cover.

CAUTION: Do not accelerate the engine rapidly, or operate it at high speed immediately after starting.



STARTING VALVE: Screw spring retainer down to dimension shown and insert cotter pin.

ROCKER ARMS: Running clearance .0014". Bushing Dia., .967 to .968".

VALVE TAPPET CLEARANCE—HOT: .018". Recheck after tightening rocker arm assembly or cylinder head. Refer to Instruction Book to set valves.

VALVE SPRING: Should measure 2½" when compressed 62 to 68 lbs. Spring free length 3 1/16"

VALVE AND VALUE GUIDE: Clearance—intake .003"; exhaust .004"; valve guides for repairs are reamed to size. Valve stem dia.—intake .4315"; exhaust .4325". Guide assembled with sharp-edged chamfer at top, and top should be 1⅜" above head.

VALVE SEAT WIDTH: 3/32." Seat must be .002" concentric with valve guide bore.

INJECTION NOZZLE can be readily removed by taking out two capscrews shown. Assembly should be clean and free of carbon. To clean nozzle, unscrew nozzle fitting from nozzle body. Before disassembling nozzle valve it is advisable to check the length of each valve spring to assure reassembling it to the original length. Correct pressure of assembled springs should be 34 to 35 pounds.

Nozzle should be checked with hydraulic test pump SE-905-A for correct opening pressure as follows: leakage past valve at 700 lb. per sq. in. pressure should not exceed 5 drops per minute. Valve should be set to open at 700 lb. per sq. in. pressure.

SPARK PLUGS: Gap should be set .035 to .040"

PISTON RINGS: When reringing a used piston, fit rings to smallest section of sleeve. Ring gap .010 to .020". Ring clearance in groove: top compression .005"; 2nd comp. .004"; 3rd & 4th .003"; two oil control rings .002". Ring grooves should be clean and free from carbon and the oil holes in oil control grooves drilled out. Stagger ring gaps around piston.

PISTON: Lynite type. Piston is a select fit with sleeve to give .0085 to .0095" measured clearance using a ½" wide ribbon gauge. A light pull of 2 to 4 lbs. should remove .008" ribbon (GO Limit). A heavy pull of 11 to 14 lbs. on a .009" ribbon indicates a (No GO Limit).

PISTON PIN: Pin floats in rod and piston and is held in piston by retainer rings. Piston and rod bushing should be burnished and reamed to give .0001 to .0003" clearance in piston and .0003 to .0005" in the rod. Heat piston when assembling pin to piston. Oversize pin (.005") is available.

BOSCH FUEL INJECTION PUMP:

Fuel injection starts 4° before T.D.C. on compression stroke. "SI" mark on flywheel (19° before T.D.C.) is point at which inlet port in pump plunger barrel is closed by rising plunger. Actual injection into cylinder occurs approximately 15° later. Point of injection can be advanced or retarded by changing relative position of adjuster and timing coupling at the drive end of injection pump. The slots in coupling allow advance or retard of 14° on the flywheel. When replacing pump, turn engine to "SI" mark for No. 1 cylinder, place coupling on drive shaft set pump "SI" mark even with groove in face of pump and fasten all parts at this setting. Move governor control lever on serrations of shaft for full travel of throttle.

CYLINDER SLEEVE PACKING RING: Renew ring whenever a sleeve is assembled. Dip ring in a warm soap solution to which a little glycerine has been added before installing it. Grooves should be clean.

CONNECTING ROD: Rod should be straight, free from twist and parallel with piston. Cylinder numbers are stamped on rod and cap and should be assembled toward camshaft side of engine.

Piston and connecting-rod assembly may be removed and replaced from bottom of engine without removing head. If assemblies are removed be sure to install them in the same relative position; rods and crankcase are numbered to facilitate assembly.

CONNECTING-ROD BEARINGS: Precision type; vertical running clearance .003 to .004". Replacement crankshaft and bearings are available in 1/32" undersize. NOTE: When assembling bearing shells be sure the bearing backs and rods are absolutely clean and dry.

CYLINDER SLEEVE: Sleeve should fit free in crankcase. Try sleeve before installing packing ring.

FIG. 34 — SERVICE CHART

but after 30 days their condition should be checked again and a charge applied if necessary. If the storage period is to be longer than 60 days, the electrolyte should be drained out of the batteries and each cell rinsed out with water. Preserve the electrolyte in glass or crockery containers, *not metal*. If the electrolyte is not drained out due to the 60 day maximum storage period, the batteries should be stored where the temperature is not below 32°F. (0°—C.). If the batteries have been drained, they may be stored at any temperature.

48. PREPARATION FOR SERVICE AFTER STORAGE

a. ***Procedure***—To restore units to service proceed as follows:

(1) Remove the spark plugs and put the compression release lever in the gasoline (starting) position, and pour a mixture of one-half gasoline and one-half grade SAE-10, lubricating oil into each cylinder (two tablespoonfuls per cylinder is enough).

(2) Remove the valve housing cover and flush the valve and the valve operating mechanism with same mixture.

(3) Crank the engine rapidly until the excess oil has been blown out of the spark plug holes. This operation will loosen any tight piston rings and wash the old gummy oil from the valves and the pistons.

(4) Flush out the crankcase with kerosene and fill it with the specified grade of lubricating oil. (See "Lubrication chart.")

(5) Drain the oil from the injection pump and refill the pump to the proper level with the specified grade of lubricating oil.

(6) Be sure the filter has a new element before starting the engine.

(7) Remove all coverings from exhaust pipe openings.

(8) Install the spark plugs.

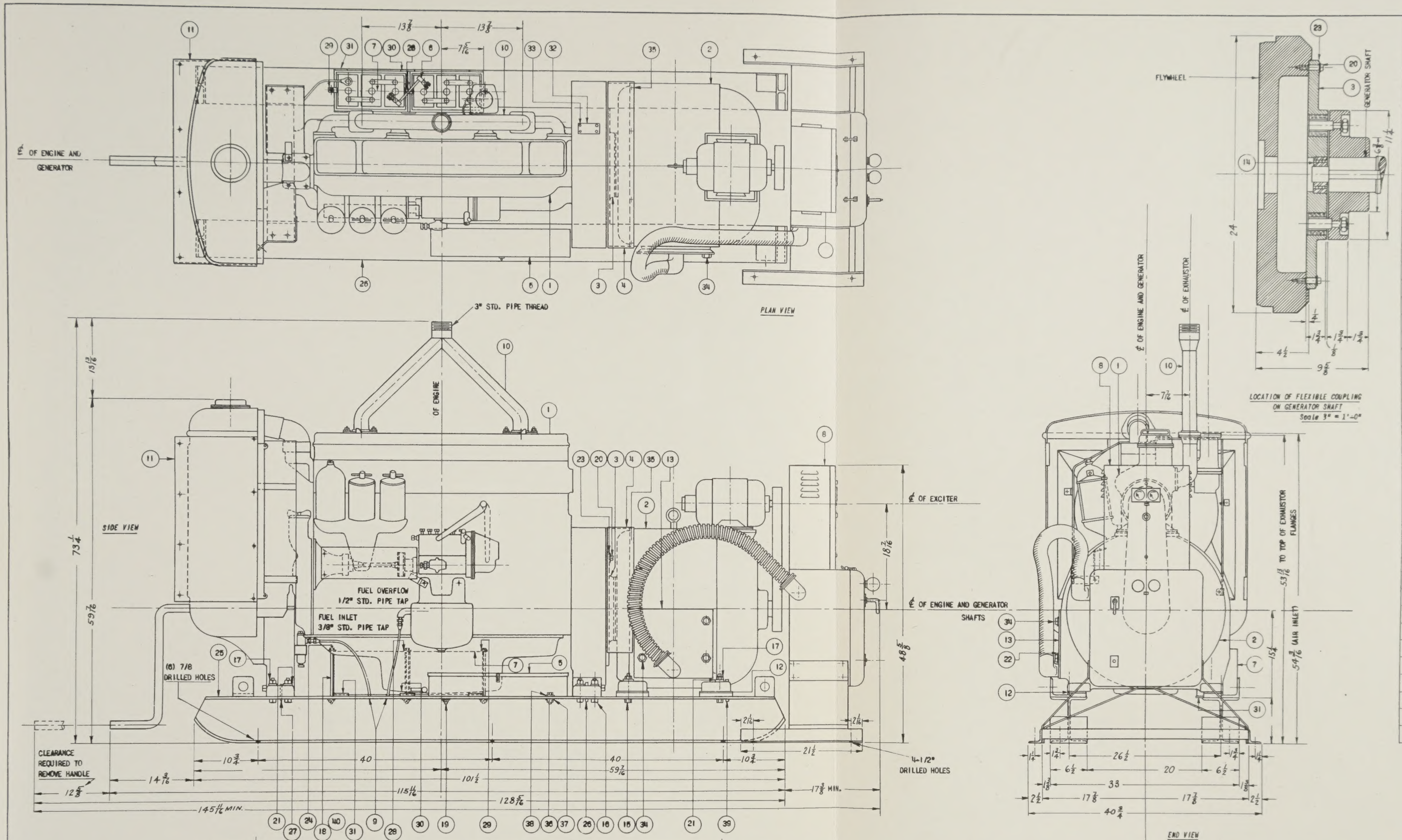
(9) Fill the water cooling system.

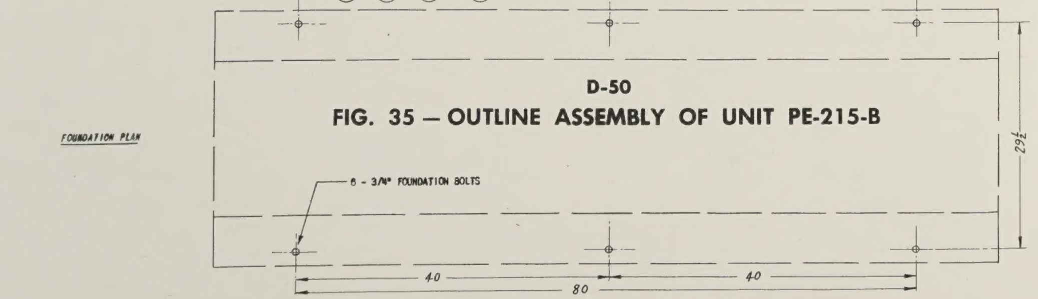
(10) Fill the fuel tanks.

(11) Start the engine and let it run slowly. Observe if any valves are sticking. If so, pour a small quantity of fuel oil or kerosene on the valve stems until the valves become loose.

(12) Assemble the valve housing cover.

CAUTION: Do not accelerate the engine rapidly, or operate it at high speed immediately after starting.


PLAN VIEW
℄ OF ENGINE AND GENERATOR
13 7/8
13 7/8
7 5/16
3" STD. PIPE THREAD
℄ OF ENGINE
SIDE VIEW
FUEL OVERFLOW 1/2" STD. PIPE TAP
FUEL INLET 3/8" STD. PIPE TAP
(6) 7/8 DRILLED HOLES
℄ OF EXCITER
℄ OF ENGINE AND GENERATOR SHAFTS
4-1/2" DRILLED HOLES
CLEARANCE REQUIRED TO REMOVE HANDLE
13 13/16
73 1/4
59 7/16
18 7/16
48 5/8
10 3/4
40
40
59 7/16
10 1/2
10 3/4
21 1/2
2 1/16
14 9/16
12 5/8
115 11/16
128 5/16
145 11/16 MIN.
17 3/8 MIN.
FLYWHEEL
GENERATOR SHAFT
24
11 1/4
4 1/2
9 5/8
LOCATION OF FLEXIBLE COUPLING ON GENERATOR SHAFT
Scale 3" = 1'-0"
℄ OF ENGINE AND GENERATOR
℄ OF EXHAUSTOR
7 1/16
53 1/8 TO TOP OF EXHAUSTOR FLANGES
54 3/4 (AIR INLET)
15 1/4
26 1/2
6 1/2
20
6 1/2
33
17 3/8
17 3/8
2 1/2
40 3/4
END VIEW


FOUNDATION PLAN
6 - 3/4" FOUNDATION BOLTS
40
40
80
29 1/2

D-50

FIG. 35 — OUTLINE ASSEMBLY OF UNIT PE-215-B

ITEM NO.	NAME	V M	VENDOR MFR.	No. Req.	Reference Dwg.	Reference Part
1	ENGINE, MODEL UD 18	M	INTERNATIONAL HARVESTER	1	13	X
2	50 KW GENERATOR	M	GENERAL ELECTRIC CO.	1	5A	2
3	3-1/8 BO FLEXIBLE COUPLING	M	AJAX	1	5A	3
4	COUPLING GUARD			1	5A	X
5	TOOLBOX AND TOOLS			1	10	X
6	BATTERY CONNECTORS			1 SET	11	X
7	6 VOLT BATTERY			2	5A	7
8	CIRCUIT BREAKER-VOLTAGE REGULATOR UNIT			1	22A	X
9	FUEL INLET AND OVERFLOW LINES			1 SET	16	X
10	EXHAUST SYSTEM			1	8A	X
11	RADIATOR AIR DUCT ADAPTER			1	7B	X
12	GENERATOR SHIMS			1 SET	9	X
13	GENERATOR TERMINAL COVER PLATE			1	25	X
14	#230? SELF ALIGNING BEARING	M	S.K.F.	1	5A	14
15	7/8x4-1/2 HEX HD CAP SCREW			4	5A	15
16	7/8x3-1/2 HEX HD CAP SCREW			8	5A	16
17	7/8 HEX NUT			12	5A	17
18	3/8-16 SQ. HEAD MACHINE BOLT			3	5A	18
19	1/4-20x1 HEX HEAD CAP SCREW			2	5A	19
20	3/8-16x1-1/2 HEX HEAD CAP SCREW			9	5A	20
21	7/8 REGULAR LOCK WASHER			12	5A	21
22	1/2 REGULAR LOCK WASHER			4	5A	22
23	3/8 EVERLOCK LOCK WASHER (INTERNAL)			9	5A	23
24	3/8 HEX NUT			3	5A	24
25	STRUCTURAL STEEL BASE			1	2A	X
26	3/8x3-1/2 GROOVE PIN #3			1	5A	26
27	3/8x3 GROOVE PIN #3			1	5A	27
28	CENTER BATTERY CLAMP 0-27			1	5A	28
29	END BATTERY CLAMP 0-28			2	5A	29
30	CENTER BATTERY SUPPORT 0-29A			1	5A	30
31	END BATTERY SUPPORT 0-30A			2	5A	31
32	NAME PLATE			1	14A	X
33	#4 TYPE 2 SELF TAPPING SCREWS 3/16 LG BINDING HD.	M	PARKER KALON	4	5A	33
34	1/2-13 HEX HEAD CAP SCREWS 3/4 LONG			4	5A	34
35	1/4-20 TYPE F HEX HD SELF TAPPING SCREW 1/2 LONG			6	5A	35
36	1/4-20 HEX NUT			2	5A	36
37	1/4 REG. LOCK WASHER			2	5A	37
38	1/4 REG. FLAT WASHER			2	5A	38
39	1/2x3-1/2 GROOVE PIN #3			2	5A	39
40	3/8 REG. LOCK WASHER			3	5A	40

ENGINE AND GENERATOR DATA

ENGINE		GENERATOR	
MODEL	INT. HARVESTER UD-18	MODEL OR FRAME	953 E, FORM-HA
TYPE	DIESEL ENGINE	FULL LOAD RATING	50 KW
CYCLE	FOUR STROKE	TEMP. RISE	40° C
BORE AND STROKE	4-3/4 x 6-1/2	VOLTS	240
DISPLACEMENT	691.12 CU. IN.	FULL LOAD CURRENT	150 AMP
SPEED	1200 R.P.M.	SPEED	1200 R.P.M.
B.H.P.	AT 1200 R.P.M.= 91		

WEIGHTS

ENGINE AND RADIATOR	3127
ENGINE ACCESSORIES ETC	400
GENERATOR	1680
BASE	514

NO	ITEM	DATE	BY	CHK	APP.

REVISIONS

INTERNATIONAL DIESEL ELECTRIC CO., INC.
35-50 - 38th STREET L.I.C., N.Y.

OUTLINE ASSEMBLY OF 50 KW
GENERATING UNIT

SCALE 1½"=1'-0" & 3"=1'-0"
DATE MARCH 22ND 1943
DR. BY F.B. TR BY G.L.
CH. BY F.B.B. APP. BY J.S.S.
NO. 631-5A

APPENDIX

INTRODUCTION TO PARTS LIST

To aid in locating the various parts, the list is divided into units shown in the index below. Each unit is illustrated with an "exploded" view which shows the unit disassembled so that the parts wanted may be readily identified. The reference numbers shown on the illustration are merely to assist in locating the part in the list *and should never be used for ordering parts; always use the part number which is shown in the list accompanying the illustration.*

Standard parts such as bolts, cap screws, lock washers, nuts, etc., are listed with and indented from the part they attach. These standard parts must be ordered separately as they are not a component part of the piece they attach. The N.C. and N.F. designations following the descriptions on some of the standard parts mean "National Coarse Thread" and "National Fine Thread".

PARTS LIST INDEX

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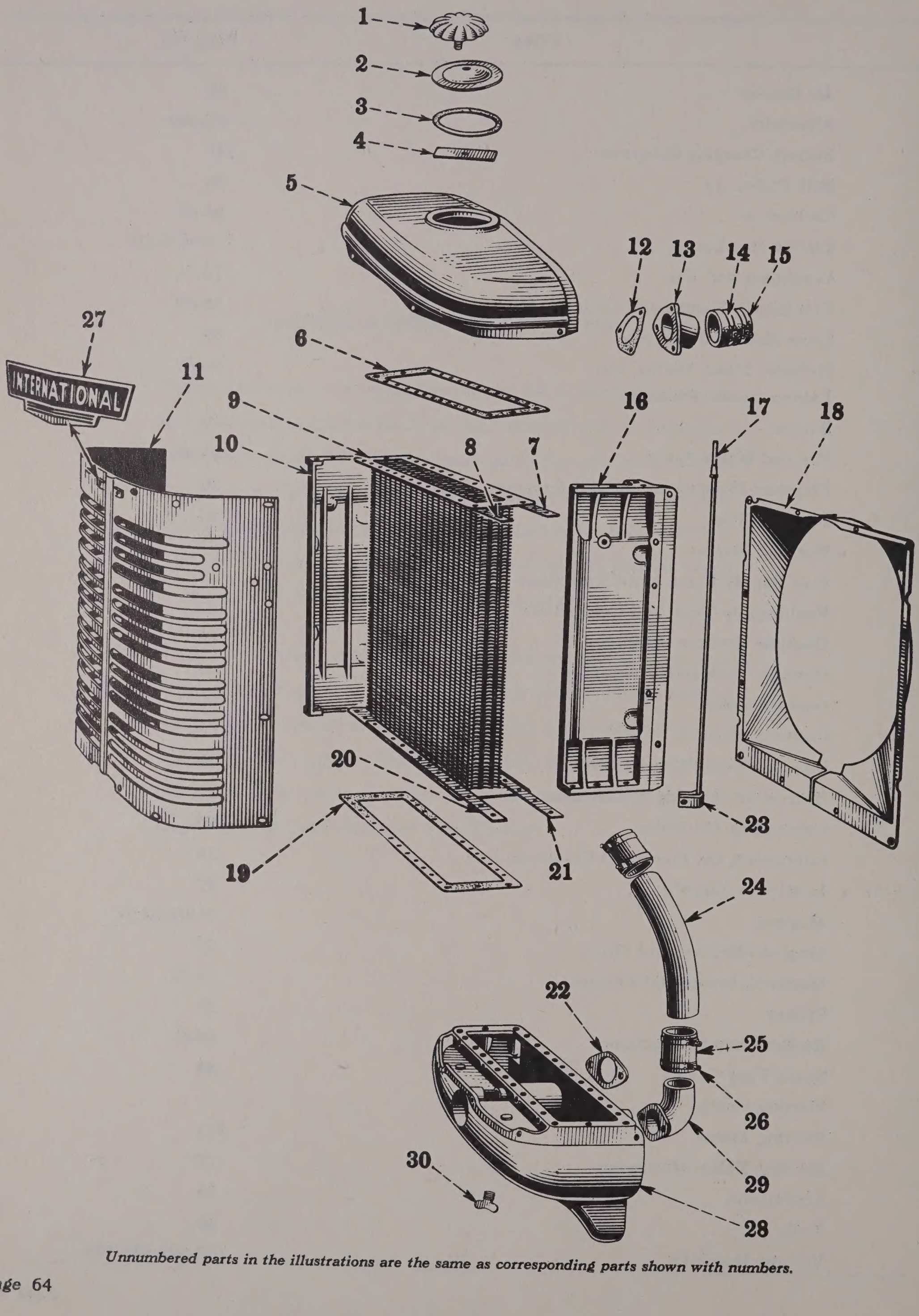
RADIATOR, GRILLE AND CONNECTIONS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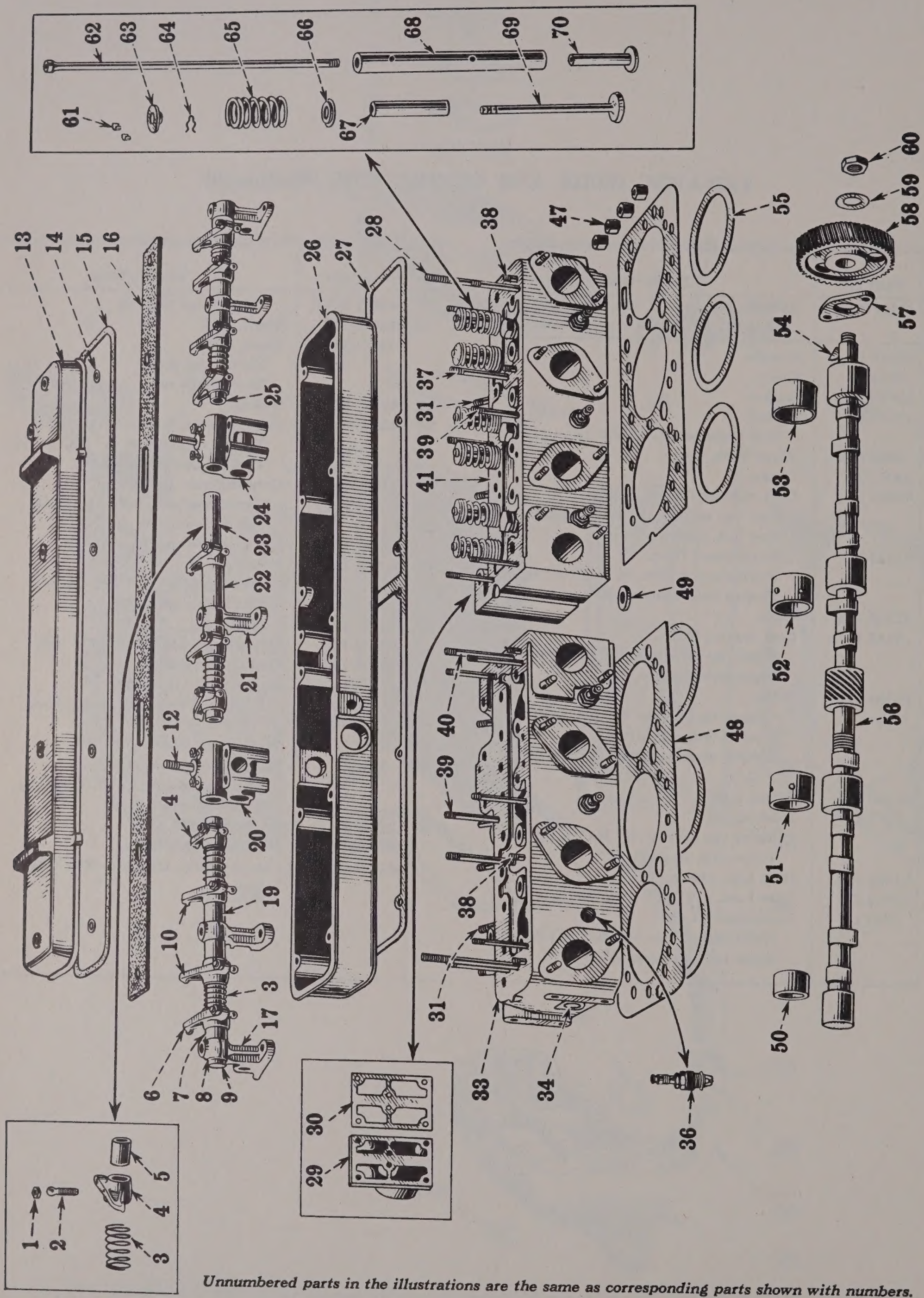
Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

RADIATOR, GRILLE AND CONNECTIONS (Continued)

REF. No.	PART No.	DESCRIPTION
	52527 DC	Radiator (includes Ref. Nos. 5 to 10, 19 to 21, 28 and 30).
1	42610 D	Handle.
2	5913 D	Cover.
3	10429 D	Gasket.
4	42158 D	Clamp.
..	....	One brass cotter, 5/32 x ¾″.
5	5940 DA	Water tank, upper.
6	68072 D	Gasket.
7	42599 D	Core stiffener, upper, rear.
..	....	Ten cap screws, ⅜″ N.C. x 1¼″.
..	....	Ten lock washers, ⅜″.
8	42534 D	Core stiffener, front.
..	....	Twelve cap screws, ⅜″ N.C. x 1¼″.
..	....	Twelve lock washers, ⅜″.
9	42538 DA	Core.
10	5945 D	Core spacer, R.H.
..	....	Eight cap screws, ½″ N.C. x 1¾″.
..	....	Eight lock washers, ½″.
11	52531 D	Grille.
..	....	Sixteen cap screws, ⅜″ N.C. x ¾″.
..	....	Sixteen lock washers, ⅜″.
..	....	Sixteen washers, 13/32″ I.D. x ⅞″ O.D.
12	42536 D	Elbow gasket.
13	5942 D	Inlet elbow.
..	....	Three cap screws, ⅜″ N.C. x 1¼″.
..	....	Three lock washers, ⅜″.
14	91406 H	Inlet hose clamp.
15	42612 D	Inlet hose, 2⅞″ I.D. x 2⅞″ long.
16	5944 D	Core spacer, L.H.
..	....	Eight cap screws, ½″ N.C. x 1¾″.
..	....	Eight lock washers, ½″.
17	42601 DAX	Overflow pipe less clip.
18	42544 DA	Sheet, L.H.
	42545 DA	Sheet, R.H.
..	....	Eleven cap screv ″ N.C. x ¾″.
..	....	Eleven lock wash ⅜″.
19	42537 D	Gasket.
20	42534 D	Core stiffener, front.
..	....	Twelve cap screws, ⅜″ N.C. x 1¼″.
..	....	Twelve lock washers, ⅜″.
21	42600 D	Core stiffener, lower, rear.
..	....	Ten cap screws, ⅜″ N.C. x 1¼″.
..	....	Ten lock washers, ⅜″.
22	32181 D	Outlet elbow gasket.
23	42914 D	Pipe clip.
..	....	One cap screw, ⅜″ N.C. x ¾″.
..	....	One lock washer, ⅜″.
24	52528 D	Outlet pipe.
25	42614 D	Outlet hose, 2⅜″ I.D. x 2⅞″ long.
26	29976 D	Outlet hose clamp.
27	43144 D	Name plate (International).
..	....	Four oval head machine screws, No. 8—32 x ⅜″.
28	8261 D	Water tank, lower.
29	8262 D	Radiator outlet elbow.
..	....	Two cap screws, ½″ N.C. x 1¼″.
..	....	Two lock washers, ½″.
30	27843 D	Radiator drain plug.
..	42589 D	Radiator repair tube.
..	42611 D	Cap assembly (includes Ref. Nos. 1 to 4).

CYLINDER HEAD, VALVES, ETC.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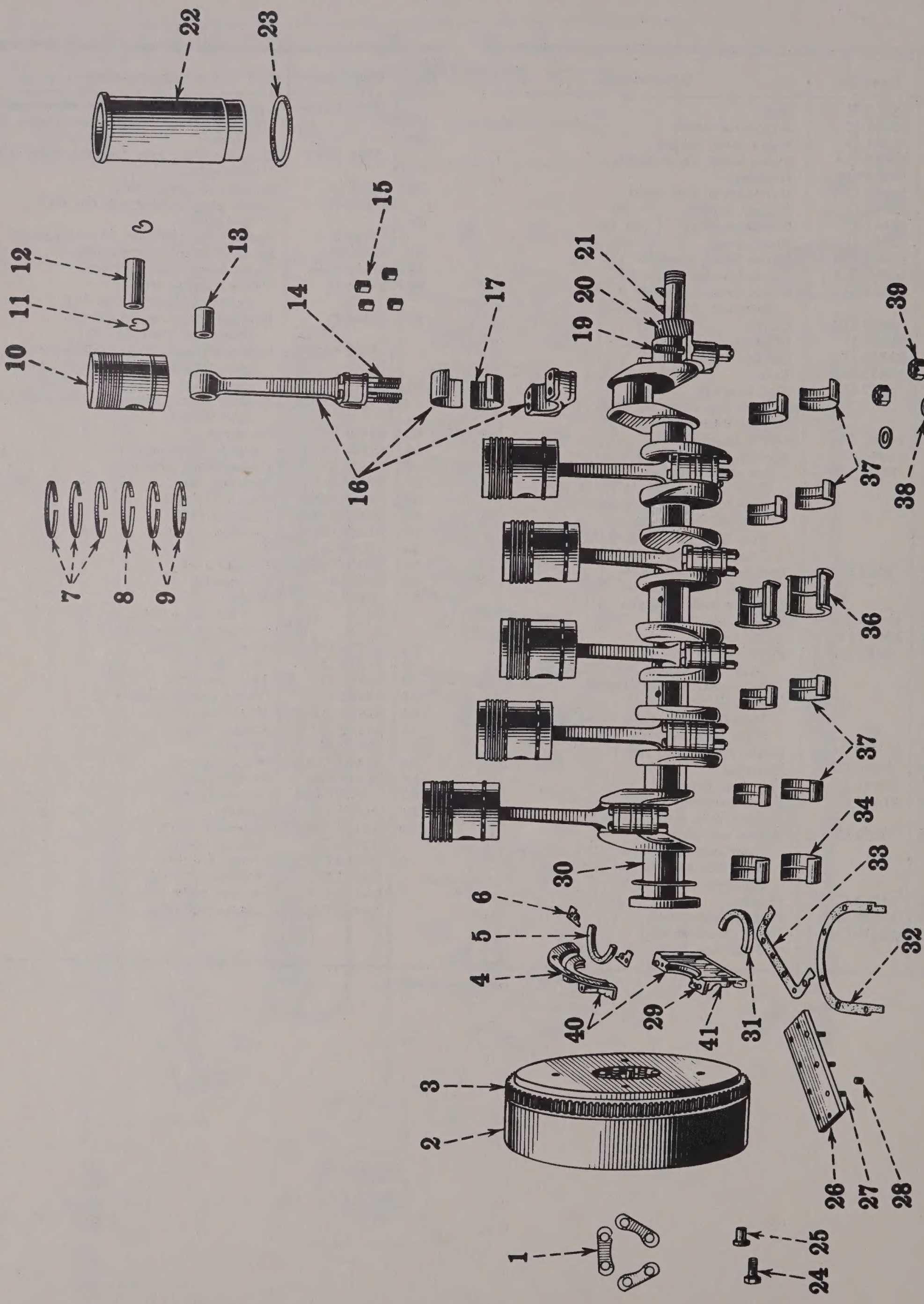
Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

CYLINDER HEAD, VALVES, ETC. (Continued)

REF. No.	PART No.	DESCRIPTION
1	38763 H	Nut.
2	10951 D	Adjusting screw.
3	24961 D	Valve lever spring.
4	32468 DX	Valve lever, right hand.
5	24965 DA	Bushing.
6	32467 DX	Valve lever, left hand.
7	24962 D	Spacer, outer
8	27141 D	Retainer ring.
9	13083 D	Shaft plug.
10	32466 DX	Valve lever, straight.
11	32468 DX	Valve lever, right hand.
12	32463 D	Front center bracket stud.
. .	. . . .	Two hex. nuts, ½″ N.F.
13	5020 DB	Cover.
14	32459 D	Washer.
15	32458 D	Gasket.
16	32462 D	Felt.
17	5027 DB	End bracket.
. .	. . . .	Two hex. nuts, ⅜″ N.F.
. .	. . . .	Two lock washers, ⅜″.
18	24961 D	Valve lever spring.
19	24964 D	Spacer, intermediate.
20	5972 DX	Cross shaft bracket.
. .	. . . .	Four cap screws, ⅜″ N.C. x 3″.
. .	. . . .	Two headless set screws, 5/16″ N.C. x ¾″.
. .	. . . .	Two hex. jam nuts, 5/16″ N.C.
. .	. . . .	Four lock washers, ⅜″.
21	5028 D	Bracket, intermediate.
. .	. . . .	Three hex. nuts, ⅜″ N.F.
. .	. . . .	Three lock washers, ⅜″.
22	32465 D	Spacer, center.
23	32464 D	Shaft, center.
24	5029 DX	Front center bracket.
. .	. . . .	Four cap screws, ⅜″ N.C. x 3″.
. .	. . . .	Two headless set screws, 5/16″ N.C. x ¾″.
. .	. . . .	Two hex. jam nuts, 5/16″ N.C.
. .	. . . .	Four lock washers, ⅜″.
25	27140 DCX	Shaft (front and rear).
26	5970 DX	Housing.
27	32457 D	Housing gasket.
28	32447 DA	Front bracket stud.
. .	. . . .	Four hex. nuts, ½″ N.F.
29	5973 D	Water manifold.
. .	. . . .	Four cap screws, ⅜″ N.C. x 1¼″.
. .	. . . .	Two cap screws, ⅜″ N.C. x 3″.
. .	. . . .	Six lock washers, ⅜″.
30	42762 D	Gasket.
31	54158 D	Nozzle body stud.
32	32447 DA	Front bracket stud.
. .	. . . .	Four hex. nuts, ½″ N.F.

REF. No.	PART No.	DESCRIPTION
33	5968 DAX	Cylinder head, rear, with valve guides, gasket rings, studs and plugs, less valves.
	5968 DAY	Cylinder head, rear, includes 5968 DAX, with valves.
34	13000 D	Expansion plug, 1⅛″.
36	31536 D	Spark plug (Champion No. 44) (optional).
	32713 D	Spark plug (AC No. 18) (optional).
37	32448 D	Bracket stud, intermediate.
38	32445 D	Valve lever bracket stud.
39	32444 D	Valve housing stud.
. .	. . . .	Twelve hex. nuts, ⅜″ N.F.
40	32448 D	Bracket stud, intermediate.
. .	. . . .	Three hex. nuts, ½″ N.F.
41	5967 DAX	Cylinder head, front, with valve guides, gasket rings, studs and plugs, less valves.
	5967 DAY	Cylinder head, front, includes 5967 DAX with valves.
47	32454 D	Stud nut.
48	42763 D	Gasket, front and rear.
49	32455 D	Center stud washer.
50	32283 DAR	Bearing, rear.
51	32282 DBR	Bearing, No. 3.
52	32281 DAR	Bearing, No. 2.
53	32280 DBR	Bearing, front.
54	13055 D	Key.
55	25090 DD	Gasket ring.
56	56464 D	Camshaft.
57	5960 D	Plate.
. .	. . . .	Two cap screws, ½″ N.C. x 1¼″.
. .	. . . .	Two lock washers, ½″.
58	32284 DA	Gear (54 teeth).
59	25323 D	Nut lock.
60	58253 D	Hex. jam nut, 1″ N.F.
61	32485 D	Valve spring collar key.
62	32486 DAX	Push rod.
63	42748 D	Upper seat.
64	18539 D	Retainer.
65	32483 DA	Valve spring.
66	18746 DA	Lower seat.
67	5025 DBR	Valve guide.
68	4988 D	Guide.
69	32482 DB	Exhaust valve.
	42747 D	Intake valve.
70	25043 DB	Valve tappet.
. .	13083 D	Expansion plug, ¾″.
. .	31121 D	Nozzle body stud nut.
. .	50410 DA	Oil header plug, ⅛″.

CRANKSHAFT, PISTONS, PISTON RINGS, ETC.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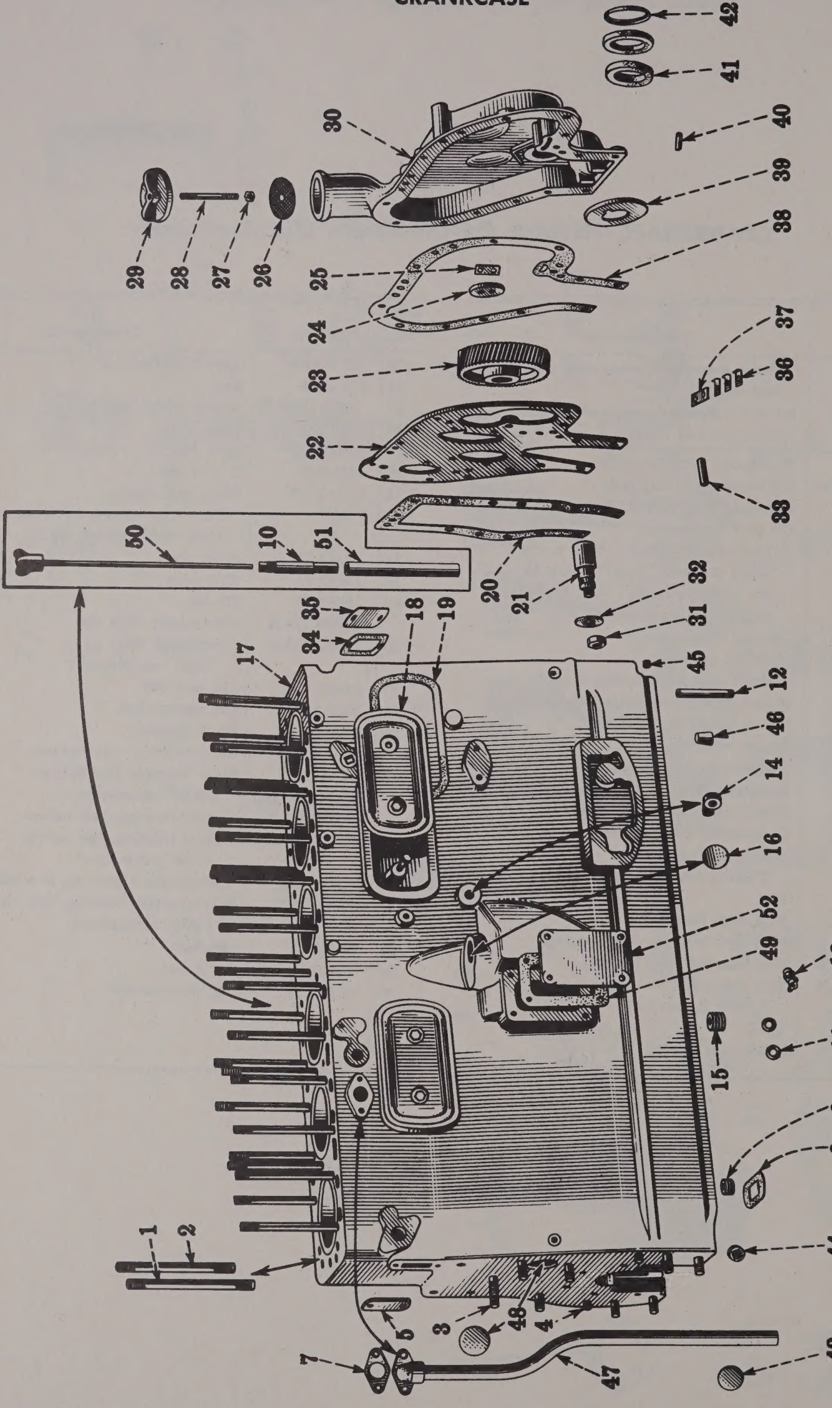
Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

CRANKSHAFT, PISTONS, PISTON RINGS, ETC. (Continued)

REF. No.	PART No.	DESCRIPTION
	42695 D	**Cylinder sleeve and piston with pin and rings.**
	42696 D	**Set of 6 cylinder sleeves and pistons with pins and rings.**
1	24943 D	Bolt lock.
2	9565 DMX	Flywheel with ring gear.
3	36237 DA	Flywheel ring gear (195 teeth).
4	39401 D	Oil seal retainer.
. .	. . . .	Two cap screws, ⅜″ N.C. x 3½″.
. .	. . . .	Eight washers, 13/32″ I.D. x ¾″ O.D.
. .	. . . .	Six cap screws, ⅜″ N.C. x 1⅜″.
. .	. . . .	Eight lock washers, ⅜″.
5	32307 DA	Oil seal felt.
6	32308 D	Retainer gasket.
7	31458 D	Piston ring—compression (plain).
8	42694 D	Piston ring—compression (taper face).
9	42219 D	Piston ring—oil regulating.
10	5957 DX	Piston with pin.
	5957 DY	Piston with pin and rings.
11	26916 D	Retainer ring.
12	53612 D	Piston pin (.005″ oversize).
13	32942 D	Connecting rod bushing.
14	28737 DX	Bolt with nut.
. .	. . . .	Twenty-four cotters, 3/32 x 1″.
15	28738 D	Nut.
16	42687 DX	Rod with bushing.
	42687 DY	Rod with bushing and bearing.
17	42688 DAX	Rod bearing (two halves).
	42690 DAX	Rod bearing (two halves) (.030″ undersize).
19	43113 D	Stud.
. .	. . . .	Sixteen cotters, ⅛ x 1⅜″.

REF. No.	PART No.	DESCRIPTION
20	25134 DA	Gear (27 teeth).
21	PO 9696	Key.
22	3202 DBRX	Sleeve with ring.
23	4222 D	Ring.
24	43054 D	Bolt, ⅝″.
25	43055 D	Dowel pin.
26	32310 DX	Plate with studs.
. .	. . . .	Four cap screws, ⅜″ N.C. x 1″.
. .	. . . .	Four lock washers, ⅜″.
27	32311 D	Plate stud.
28	25093 D	Felt plug.
29	25076 D	Dowel.
30	32288 DAX	Crankshaft with nut.
	32305 DAX	Crankshaft with nut (.030″ undersize).
31	32307 DA	Oil seal felt.
32	32309 D	Oil seal gasket.
33	32312 D	Plate gasket.
34	47759 DX	Rear bearing, two halves.
	47763 DX	Rear bearing, two halves (.030″ undersize).
	63327 DX	
36	~~47758 DAX~~	Center bearing, two halves.
	47762 DAX	Center bearing, two halves (.030″ undersize).
37	47757 DX	Intermediate bearing, two halves.
	47761 DX	Intermediate bearing, two halves (.030″ undersize).
38	39422 D	Washer.
39	39423 D	Stud nut.
40	39401 D	Oil seat retainer.

CRANKCASE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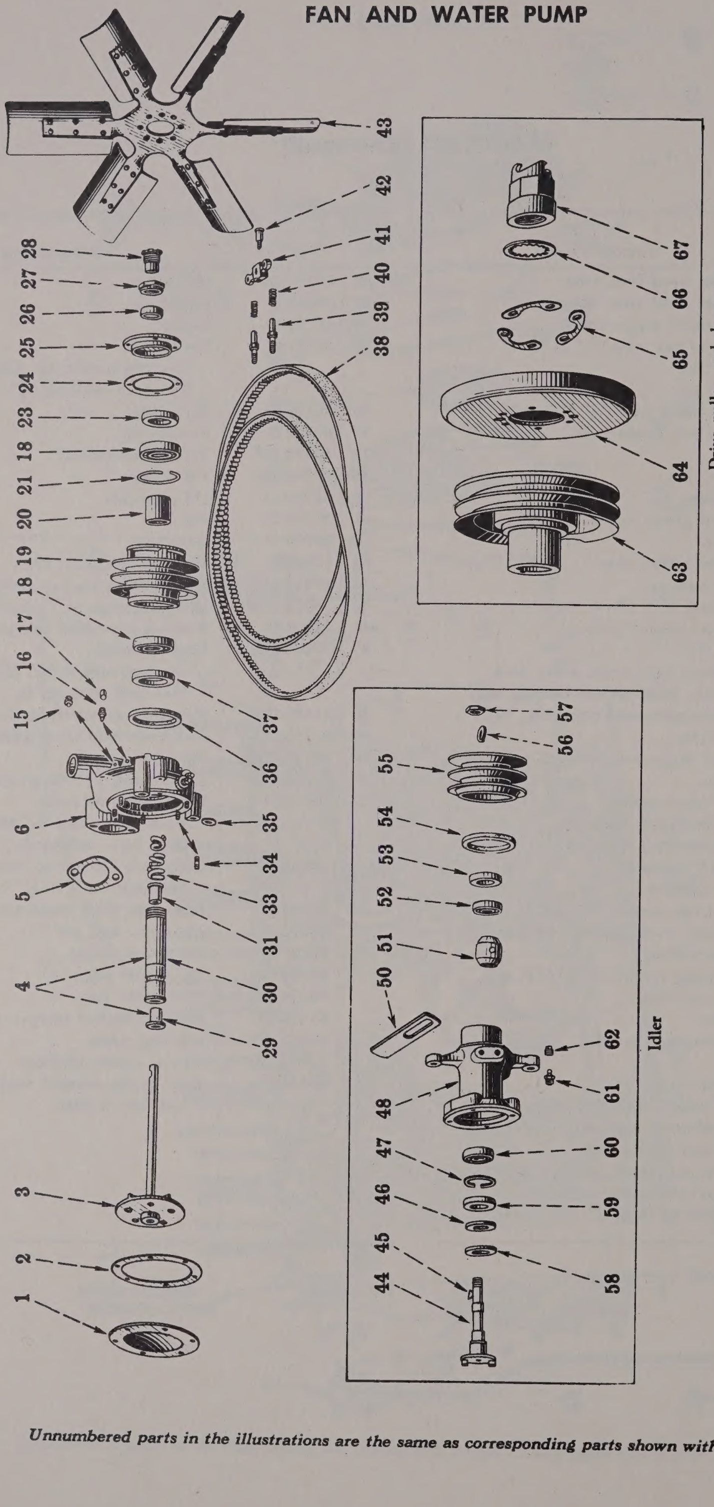
Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

CRANKCASE (Continued)

Ref. No.	Part No.	Description
1	39810 D	Cylinder head stud, long.
2	42717 D	Cylinder head stud, short.
3	42718 DB	Rear engine support stud.
..	....	Eleven hex. nuts, ⅝" N.F.
4	25086 DA	Dowel pin.
5	39763 D	Plate, rear.
..	....	Two cap screws, ⅜" N.C. x ⅞".
..	....	Two lock washers, ⅜".
7	25121 D	Gasket.
8	39764 D	Gasket.
9	....	Two plugs, ¾".
10	48262 D	Oil level gauge sleeve.
11	58511 D	Washer.
12	46351 D	Oil filter return pipe.
13	31729 D	Drain cock.
14	....	One drain cock elbow, ⅜".
15	....	One countersunk plug, 1".
16	29565 D	Plug, 1⅞".
17	6542 DEX	Crankcase with plugs, studs, pins, dowels, bushings and bearing caps
..	....	One square head pipe plug, ¼".
18	39756 D	Side plate.
..	....	Four cap screws, ⅜" N.C. x ⅞".
19	39757 D	Gasket.
20	32371 D	Front cover gasket.
21	25138 DAX 38814 DX	Idler gear shaft with pin. Idler gear shaft with pin (.015" oversize).
22	32367 DAX	Front plate.
..	....	Five cap screws, ½" N.C. x 1".
23	25140 DBX	Idler gear with bushing (64 teeth).
24	25131 D	Thrust washer.
..	....	Two cap screws, 5/16" N.F. x ¾".
25	25130 D	Cap screw lock.
26	1242 DB	Strainer.
27	....	One hex. nut, ⅜" N.C.
28	28940 D	Stud.
29	3713 DA	Oil filler cap.
30	5976 DX	Front cover with oil filler stud, oil flinger trough, oil seal felt and oil seal felt retainer.
..	....	Nine cap screws, ½" N.C. x 1¾".
..	....	Nine lock washers, ½".
31	....	One nut, ¾" N.F.
32	25132 D	Nut lock.
33	25087 D	Dowel.
34	39762 D	Gasket.
35	39761 D	Plate.
..	....	Two cap screws, ⅜" N.C. x ⅞".
..	....	Two lock washers, ⅜".
36	32370 D	Screw lock.
37	39380 D	Screw strip.
38	32368 DA	Front plate gasket.
39	36796 DA	Oil flinger.
40	25954 D	Oil pan stud.
41	36798 D	Felt.
42	36799 D	Retainer.
43	13062 D	Water jacket plug, 1½".
44	30397 D	Oil header plug, ½".
45	38028 DM	Metering plug, ⅛" (slotted).
46	52606 D	Crankcase locating hole plug (cork).
47	55307 DX	Breather pipe.
..	....	Two cap screws, ⅜" N.C. x 1¼".
..	....	Two lock washers, ⅜".
48	21826 H	Crankcase camshaft bearing plug, 2¼".
49	42733 D	Crankcase side cover gasket.
50	43156 DX	Oil level gauge.
51	51203 DA	Lubricating oil level gauge pipe.
52	8929 D	Crankcase side cover.
..	....	Four cap screws, ⅜" N.C. x 1".
..	....	Four lock washers, ⅜".
..	22891 D	Crankcase distributor hole lock washer.
..	....	One cap screw, 5/16" N.C. x ⅝".
..	29764 D	Idler gear shaft dowel pin.
..	30624 D	Starting crank pin.
..	36797 D	Oil flinger trough.
..	50410 DA	Oil header plug, ⅛".
..	50474 DA	Oil header plug, ¼".
..	51329 D	Friction control retainer plate pin.
..	52522 D	Starting crank.
..	52726 DA	Engine gasket package.
..	47415 H	Rear engine support stud nut lock washer.

FAN AND WATER PUMP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Drive pulley and dampener

Idler

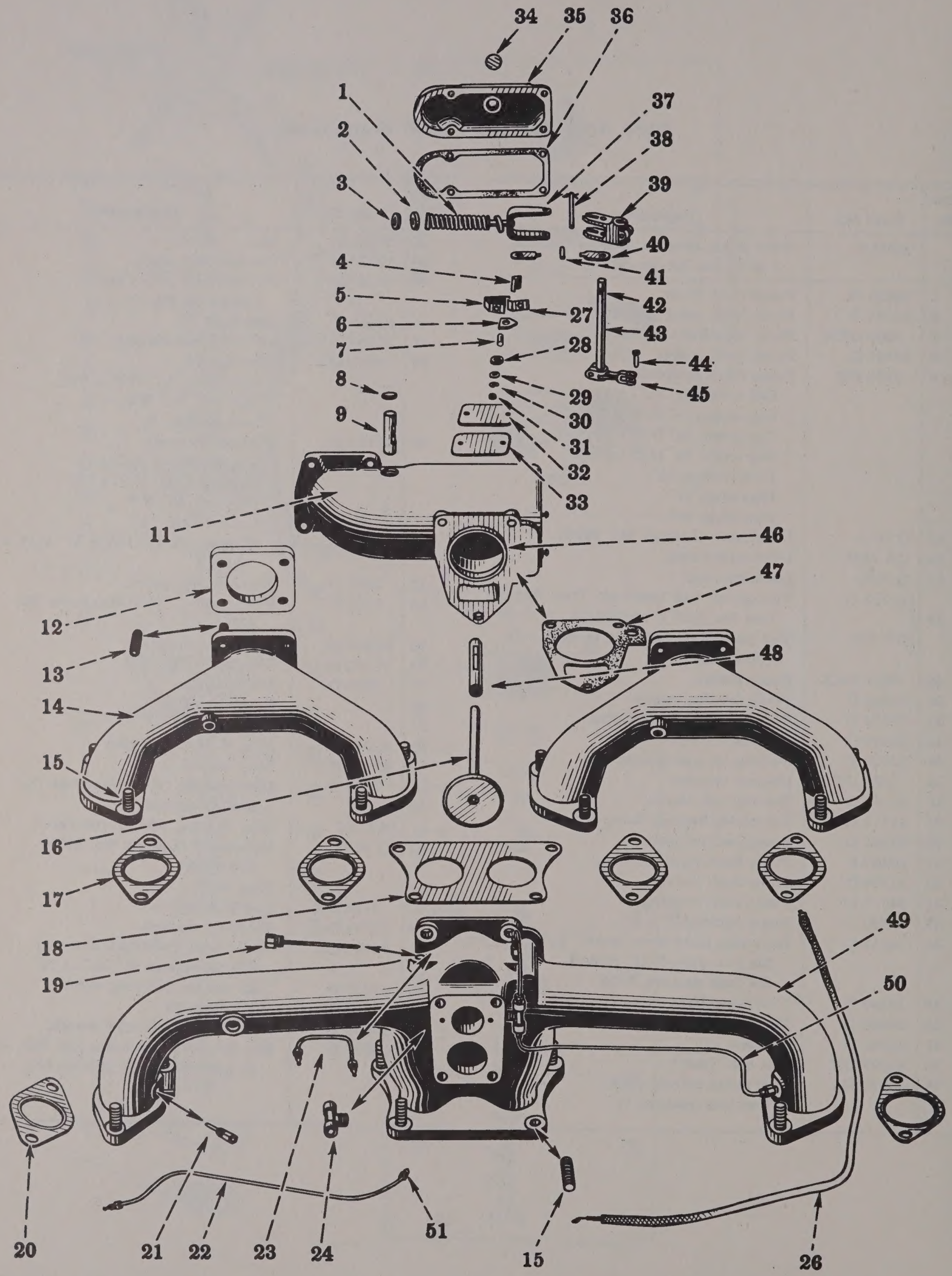
Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

FAN AND WATER PUMP (Continued)

REF. No.	PART NO.	DESCRIPTION
. .	**56357 D**	**Water pump, complete (includes Ref. Nos. 1 to 36, less Ref. No. 32).**
1	32350 D	Pump body cover.
2	32351 D	Pump body cover gasket.
3	5008 DCX	Pump impeller and shaft.
5	30824 D	Pump body gasket.
6	5950 DX	Pump body, complete.
. .	. . . .	Cap screw, ½" N.C. x 3½".
. .	. . . .	Cap screw, ½" N.C. x 2¾".
. .	. . . .	Cap screw, ½" N.C. x 3¼".
. .	. . . .	Cap screw, ½" N.C. x 2½".
. .	. . . .	Lock washer, ½".
. .	. . . .	Pipe plug, ¼".
. .	. . . .	Pipe plug, ⅜".
15	Q 3615	Lubricator (Lincoln No. 5000).
16	QA 3628	Lubricator fitting.
17	Q 3659	Lubricator cap.
18	20308 D	Two pump ball bearings (New Departure No. 3207) (optional).
	ST 205	Two pump ball bearings (IHC) (optional).
19	5010 DAX	Pump pulley.
20	32356 D	Pump bearing spacer.
21	27654 D	Pump bearing retainer ring.
23	20289 D	Oil seal.
24	32624 D	Bearing retainer gasket.
25	5009 DX	Bearing retainer.
26	20293 D	Bearing lock sleeve.
27	34315 H	Fan pulley bearing clamp nut.
28	20296 D	Pump packing gland.
29	20303 D	Pump shaft thrust bushing.
30	32354 D	Pump shaft sleeve.
31	24017 D	Pump shaft bushing.
33	50790 D	Pump packing.
34	32352 D	Six pump body cover studs.
. .	. . . .	Six hex. nuts, 5/16" N.F.
. .	. . . .	Six lock washers, 5/16".
35	32349 D	Two pump body spacers.
36	20300 D	Pump felt washer.
37	20290 D	Oil seal.
38	42937 DX	Fan belt (pair).
39	34321 HA	Two pump driving studs.
. .	. . . .	Two lock washers, ⅜".

REF. No.	PART NO.	DESCRIPTION
43	54290 D	Fan.
44	42938 D	Fan belt idler shaft.
45	13085 D	Fan belt idler pulley key (Woodruff No. 7).
46	42941 D	Idler shaft felt.
47	42939 D	Idler bearing lock ring.
48	5987 DX	Idler bracket.
. .	. . . .	Cap screw, ½" N.F. x 4½".
. .	. . . .	Hex. nut, ½" N.F.
. .	. . . .	Lock washer, ½".
50	32523 D	Idler pulley brace.
. .	. . . .	Cap screw, ⅜" N.C. x 1".
. .	. . . .	Cap screw, ⅜" N.F. x 1¼".
. .	. . . .	Hex. nut, ⅜" N.F.
. .	. . . .	Lock washer, ⅜".
. .	. . . .	Washer, 13/32" I.D. x ¾" O.D. x 16 gauge.
51	5988 D	Idler bearing spacer.
52	1266 C	Idler bearing (New Departure No. 3203).
53	42940 D	Two idler oil seals.
54	W 16210	Idler pulley felt.
55	5989 D	Idler pulley.
56	. . . .	Lock washer.
57	. . . .	Nut, ⅝" N.F.
58	42942 D	Idler shaft felt retainer.
59	42940 D	Idler oil seal.
60	8522 T	Idler bearing (New Departure No. 3204) (optional).
	ST 207	Idler bearing (IHC) (optional).
61	Q 3615	Lubricator (Lincoln No. 5000) (optional).
62	. . . .	Plug, ⅛".
63	5420 DX	Fan drive pulley.
64	36794 D	Vibration damper.
65	36795 DA	Three locks (vibration damper).
. .	. . . .	Six cap screws, ⅜" N.C. x ¾".
66	18767 D	Lock washer (starting nut).
67	5421 D	Nut (starting).
. .	10639 D	Two vibration damper dowels.
. .	63007 D	Fan belt idler (includes Ref. Nos. 44 through 48 and 51 through 62).

MANIFOLDS (INTAKE AND EXHAUST)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Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

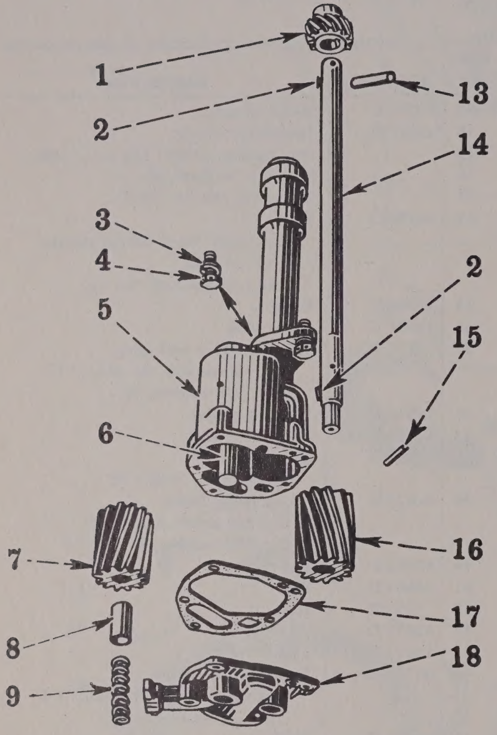
MANIFOLDS (INTAKE AND EXHAUST) (Continued)

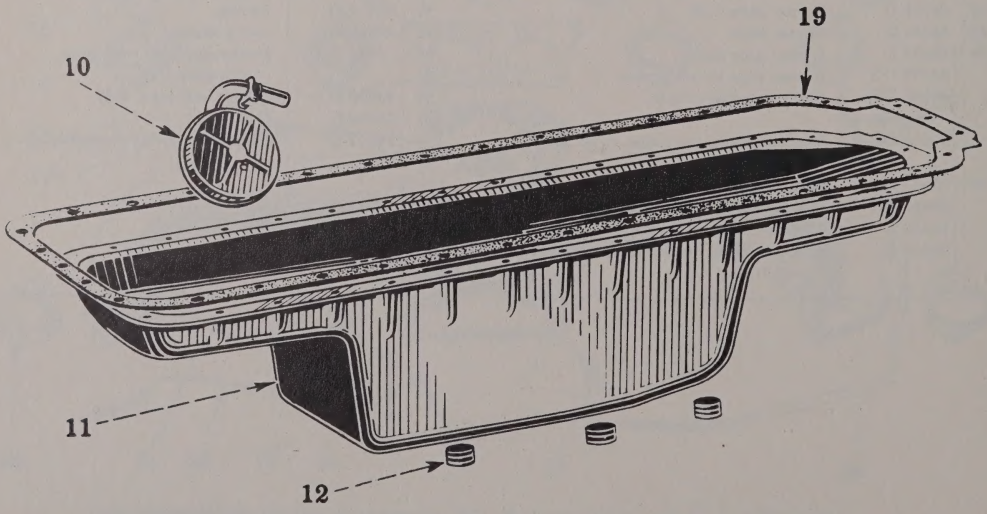
REF. No.	PART No.	DESCRIPTION
1	42663 D	Spring.
2	42665 D	Cup.
3	42664 D	Washer.
4	42673 D	Switch contact.
. .	. . . .	Two round head slotted screws, 10—32 x ⅜".
. .	. . . .	Two lock washers, No. 10.
5	42674 D	Spring.
6	42676 D	Insulator.
7	42678 D	Insulating tube.
8	13090 D	Housing plug.
9	42669 D	Pivot.
11	5953 DX	Housing.
. .	. . . .	Three cap screws, 7/16" N.C. x 1¼".
. .	. . . .	Three lock washers, 7/16".
12	5052 D	Exhaust pipe flange.
. .	. . . .	Eight hex. nuts, ½" N.C.
. .	39398 D	Exhaust pipe flange gasket.
13	32568 D	Stud.
14	52709 D	Exhaust manifold.
15	25125 D	Stud, ½".
. .	. . . .	Sixteen hex. nuts, ½" N.C.
16	42660 D	Air valve.
17	32360 D	Exhaust gasket.
18	32366 D	Center gasket.
19	43371 D	Primer spray tube.
	43371 DX	Primer spray tube with nut.
20	32495 D	Intake gasket.
21	42216 D	Tube end.
	43371 DX	Tube end with nut.
22	43369 D	Primer pipe, L.H.
23	43368 D	Center pipe.
24	43372 D	Primer pipe tee.
	43372 DX	Primer pipe tee with nuts.
26	46886 DX	Short circuiting cable.
	(consists of):	
	27618 D	Magneto short circuiting cable loom clamp ring.
	38433 D	Magneto short circuiting cable terminal.
	46886½D	Magneto short circuiting cable.
	42652 D	Magneto short circuiting cable loom.
	29016 H	Magneto short circuiting cable terminal switch end.

REF. No.	PART No.	DESCRIPTION
27	42675 D	Reinforcement.
28	42677 D	Insulating washer.
29	. . . .	One washer, 13/64" I.D. x ½" O.D.
30	. . . .	Two lock washers, No. 10.
31	. . . .	Two nuts, No. 10—24 N.C.
32	42679 D	Cover.
. .	. . . .	Two round head slotted screws, 10—24 x ½".
. .	. . . .	Two lock washers, No. 10.
33	42680 D	Gasket.
34	23007 V	Cover plug.
35	5954 DX	Housing cover with plug.
. .	. . . .	Four cap screws, ⅜" N.C. x 1".
. .	. . . .	Four lock washers, ⅜".
36	42672 D	Housing gasket.
37	42666 DX	Yoke and rod.
38	42668 D	Yoke pin.
. .	. . . .	Two cotters, 1/16 x ⅝".
39	42670 D	Valve lever, inner.
. .	. . . .	One cap screw, 5/16" N.F. x 1".
. .	. . . .	One lock washer, 5/16".
40	42662 D	Pin retainer.
41	42661 D	Pin.
42	4167 T	Key.
43	42671 D	Shaft.
44	14611 H	Pin.
45	42782 D	Control lever, outer.
. .	. . . .	One cap screw, 5/16" N.F. x 1".
. .	. . . .	One lock washer, 5/16".
46	42657 D	Ring.
47	42659 D	Gasket.
48	42658 D	Valve sleeve.
49	5955 DX	Intake manifold with plug.
. .	. . . .	One pipe plug, ¼".
50	43370 D	Primer end pipe, R.H.
51	36092 D	Nut.
. .	59247 D	Distributor switch terminal screw.

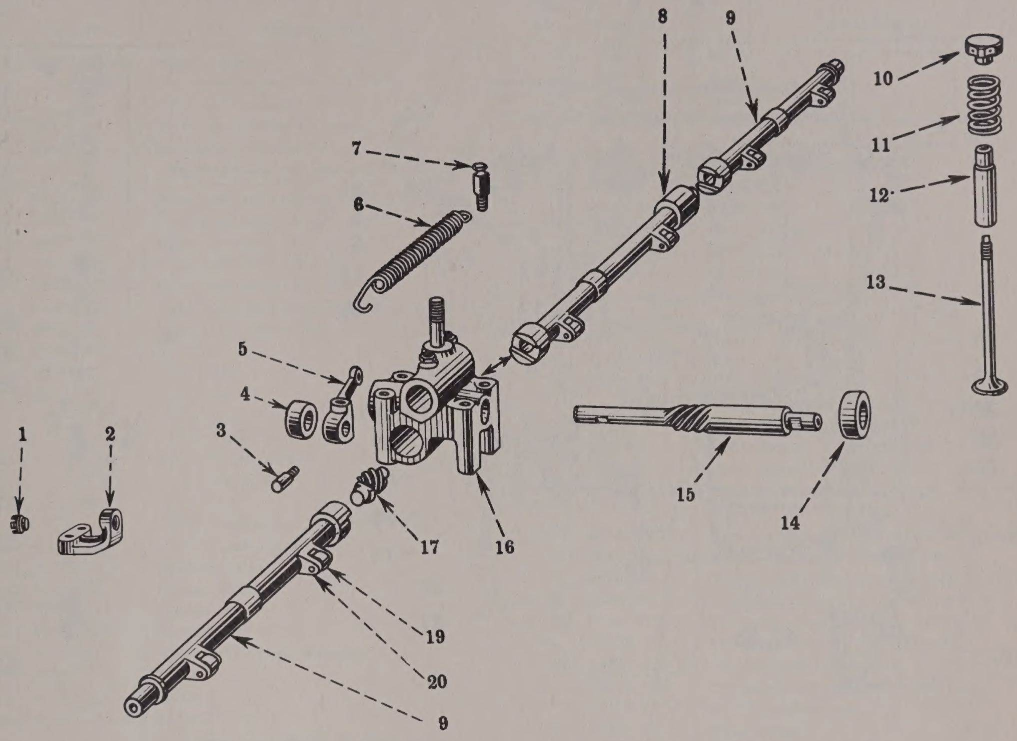
LUBRICATING OIL PUMP AND CRANKCASE PAN

Ref. No.	Part No.	Description
..	**43990 D**	**Lubricating oil pump assembly with float.**
1	46054 DA	Pinion (14 teeth).
2	13021 D	Pinion and gear key.
3	....	Two lock washers, ½″.
4	10961 D	Cap screw.
5	45963 D	Body with shaft.
6	43158 D	Idler gear shaft.
7	50336 D	Idler gear (12 teeth).
8	45285 DA	Regulating valve.
9	48695 D	Spring.
10	42791 DA	Float.
..	....	One cotter, ⅛ x 1½″.
11	6052 DX	Crankcase oil pan.
..	....	Cap screws, ⅜″ N.C. x 1¼″.
..	....	Lock washers, ⅜″.
..	....	Hex. nuts, ⅜″ N.F.
..	....	Two countersunk plugs, 1″.
12	....	One pipe plug, 1″.
13	5312 T#3	Pin.
14	43157 DX	Shaft with pin.
15	32319 D	Pin.
16	50335 D	Body gear (12 teeth).
17	42789 D	Housing gasket.
18	6055 D	Cover with pin.
..	....	Five cap screws, ⅜″ N.C. x 1″.
..	....	Five lock washers, ⅜″.
19	42715 D	Crankcase oil pan gasket.





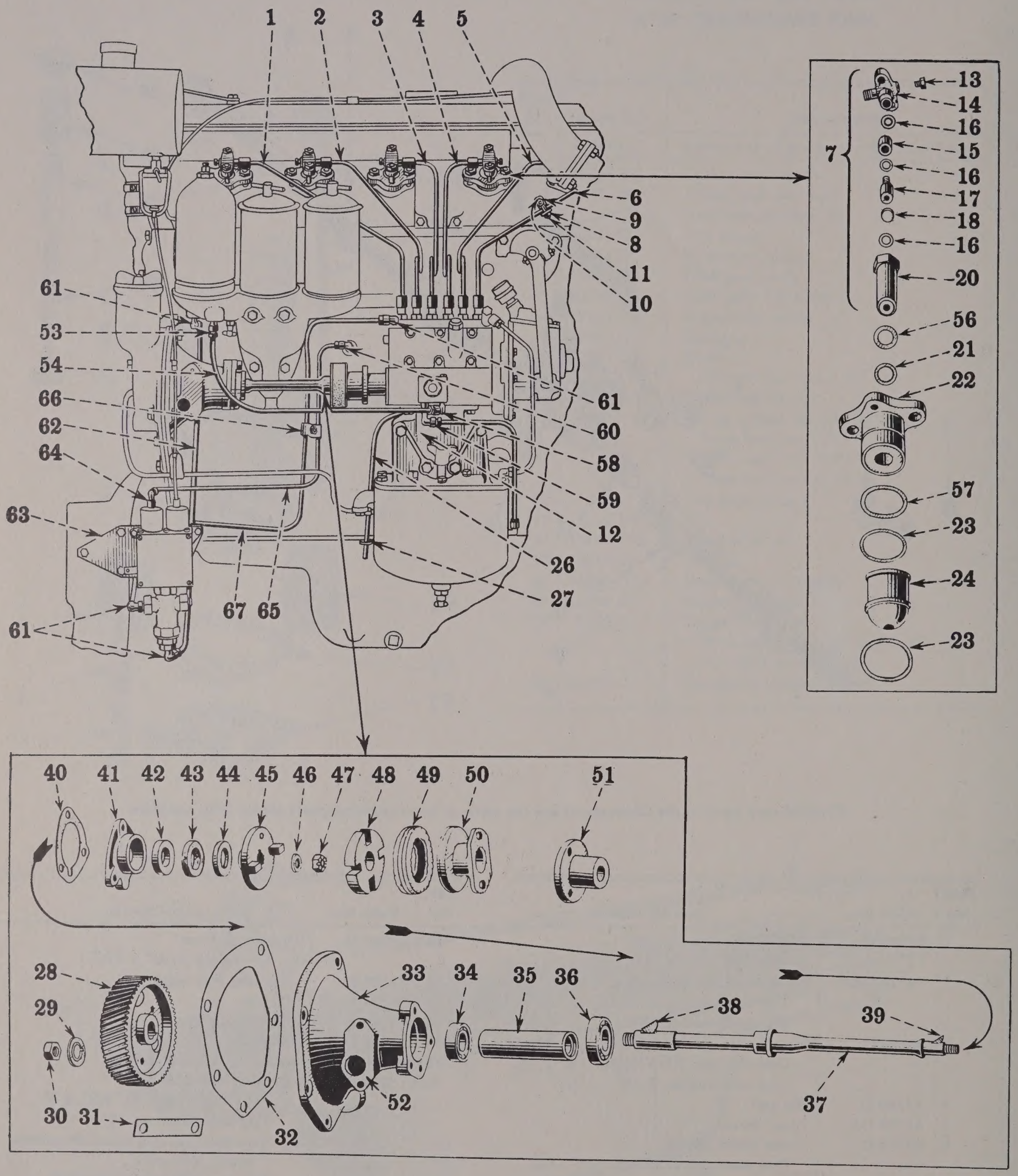
STARTING VALVE MECHANISM



Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

Ref. No.	Part No.	Description
1	42759 D	Cross shaft thrust screw.
. .	. . . .	One cotter, 3/32" x 1¼".
2	8720 DA	Cross shaft thrust bracket.
. .	. . . .	Two cap screws, ½" N.C. x 2".
. .	. . . .	Two lock washers, ½".
3	20586 D	Pin.
. .	. . . .	One hex. nut, 5/16" N.F.
. .	. . . .	One lock washer, 5/16".
4	42760 D	Oil seal.
5	42754 DA	Inner lever.
6	42755 D	Cross shaft spring.
. .	. . . .	One washer, 19/32" I.D. x 1" O.D.
. .	. . . .	One cotter, 3/32" x ⅞".
7	42756 D	Spring anchor stud.
8	32470 DX	Shaft, center, with roller.
9	32469 DX	Shaft, front and rear, with roller.
10	42750 D	Spring retainer.
. .	. . . .	Six cotters, 3/32" x 1½".
11	32479 D	Starting valve spring.
12	5024 DAR	Guide.
13	42749 D	Starting valve.
14	32460 D	Oil seal.
15	56456 D	Starting valve cross shaft.
16	5972 DX	Bracket with stud.
. .	. . . .	Four cap screws, ⅜" N.C. x 3".
. .	. . . .	Four lock washers, ⅜".
. .	. . . .	Two headless cup point set screws, 5/16" N.C. x ¾".
. .	. . . .	Two hex. jam nuts, 5/16" N.C.
17	32471 DA	Gear (8 teeth).
19	24916 D	Roller.
20	24917 D	Pin.

INJECTION PUMP CONNECTIONS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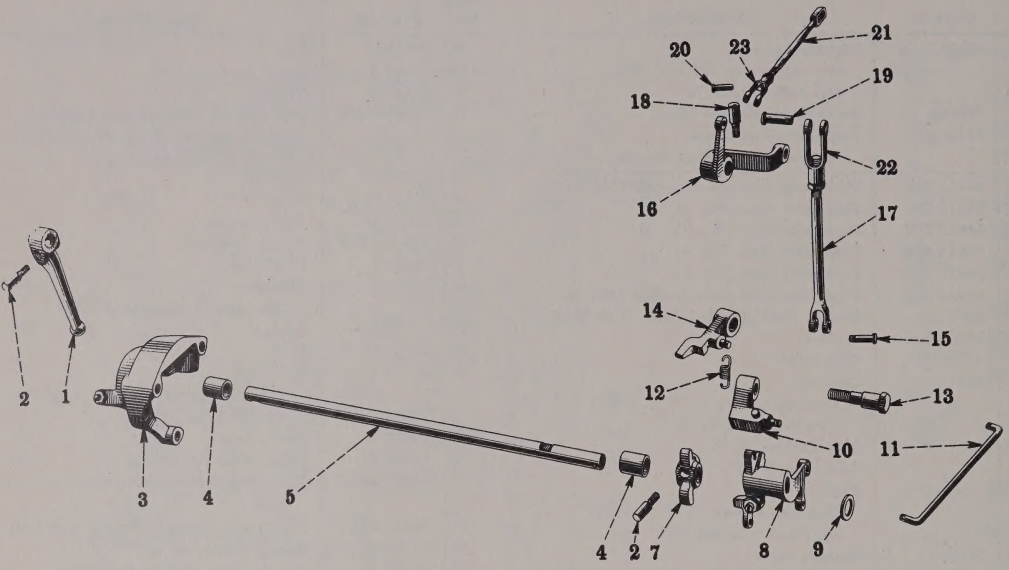
Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

INJECTION PUMP CONNECTIONS (Continued)

Ref. No.	Part No.	Description
..	**63877 D11¾**	**Injection pump.**
..	....	**Four cap screws, ⅜″ x ⅞″ N.C.**
..	....	**Four lock washers, ⅜″.**
..	**54910 D**	**Set of six (6) injection pipes.**
..	**53129 DA**	**Automatic safety control.**
..	....	**Two reducing bushings, ½ x ¼″.**
1	54911 DX	Pipe, with nuts and clip stud (No. 1).
2	54912 DX	Pipe, with nuts (No. 2).
3	54913 DX	Pipe, with nuts (No. 3).
4	54914 DX	Pipe, with nuts (No. 4).
5	54915 DX	Pipe, with nuts (No. 5).
6	54916 DX	Pipe, with nuts and clip stud (No. 6).
7	52613 D	Nozzle (includes Ref. Nos. 13 to 20).
8	27927 DA	Washer.
9	42799 D	Clip, front.
	56617 D	Clip, rear.
..	....	Two cap screws, ⅜″ N.C. x ¾″.
..	....	Two lock washers, ⅜″.
10	....	Two washers, 5/16″.
11	....	Two nuts, 5/16″.
12	5986 D	Bracket.
..	....	Four cap screws, ½″ N.C. x 2¼″.
..	....	Four lock washers, ½″.
13	32493 D	Bleeder valve.
14	52612 D	Nozzle fitting.
15	37150 D	Spacer.
16	37148 D	Gasket.
17	37152 D	Valve and spring assembly.
18	43192 D	Plate.
19	37148 D	Gasket.
20	42766 D	Nozzle body.
..	....	Twelve cap screws, ⅜″ N.F. x 2″.
21	42767 D	Nozzle body gasket.
22	42765 DA	Nozzle body retainer.
23	43002 D	Spacer gasket.
24	56291 D	Spacer.
25	43002 D	Spacer gasket.
26	61407 DX	Injection pump overflow pipe with nut.
27	52128 D	Injection pump overflow pipe clip.
..	....	One washer, 13/32″ I.D. x ¾″ O.D.
28	25362 D	Gear (54 teeth).
29	25354 D	Nut lock.
30	....	One hex. jam nut, ¾″ N.F.
31	32341 D	Lock.
32	32340 D	Housing gasket.
33	5005 DAX	Housing with plug.
..	....	Two cap screws, ½″ N.F. x 1⅞″.
..	....	Two cap screws, ½″ N.C. x 1″.
..	....	One cap screw, ½″ N.F. x 3¾″.
..	....	One cap screw, ½″ N.C. x 1¾″.
..	....	Three hex. nuts, ½″ N.F.
..	....	Four lock washers, ½″.
34	10701 DA	Bearing, front (New Departure No. 7505).
35	32344 D	Spacer.
36	23874 D	Bearing, rear (New Departure No. 3206).
37	32345 D	Shaft.
..	....	One cotter, 3/32″ x ⅞″.

Ref. No.	Part No.	Description
38	4710 D	Key.
39	7220 T	Key.
40	32342 D	Gasket.
41	5006 DAX	Cap with oil seal, felt and retainer.
..	....	Three cap screws, ⅜″ N.C. x 1¼″.
..	....	Three lock washers, ⅜″.
42	12480 L	Oil seal.
43	32362 D	Felt.
44	32343 D	Felt retainer.
45	32346 DAX	Flange with pin.
	G 3836	Dowel pin.
46	32347 D	Washer.
47	....	One castle hex. nut, ½″ N.F.
48	31439 DB	Spacer.
49	31441 D	Boot.
50	33275 D	Adjuster.
..	....	Two cap screws, ⅜″ N.F. x ⅝″.
..	....	Two lock washers, ⅜″.
51	54909 D	Drive flange.
52	13806 D	Hour meter pad plug, 1¼″.
53	42797 DAX	Fuel filter to injection pump tube with nuts.
54	54917 DX	Primary pump to filter tube with nuts.
56	61208 D	Nozzle body dust seal.
57	61209 D	Nozzle body retainer dust seal.
58	59708 D	Injection pump oil overflow cock.
59	60743 DX	Oil level equalizing tube with nuts.
60	29898 D	Oil pressure tube coupling nut.
	36613 D	Oil pressure tube elbow.
	36613 DX	Oil pressure tube elbow with nut.
61	37165 D	Four coupling nuts.
	37323 D	Four elbows.
	37323 DX	Four elbows with nuts.
62	59201 DX	Fuel filter to safety control tube with nuts.
63	59200 D	Safety control bracket.
..	....	Three cap screws, ⅜″ N.C. x 1¼″.
..	....	Three hex. nuts, ⅜″ N.C.
..	....	Three lock washers, ⅜″.
..	....	Four cap screws, ¼″ N.C. x 1″.
..	....	Four hex. nuts, ¼″ N.C.
..	....	Four lock washers, ¼″.
..	29959 D	Two safety control spacers.
64	29898 D	Oil pressure tube coupling nut.
	30402 D	Oil pressure tube elbow.
	30402 DX	Oil pressure tube elbow with nut.
65	59203 DX	Oil pressure tube with coupling nuts.
66	16445 D	Safety control to injection pump tube felt.
	26242 D	Oil pressure tube felt.
	59204 D	Clip.
..	....	Round head, slotted screw, ¼″ N.C. x ½″.
..	....	Hex. nut, ¼″ N.C.
..	....	Lock washer, ¼″.
67	61804 DX	Safety control to injection pump tube with coupling nuts.
..	....	Reducing bushing, ¼ x ⅛″ (in crankcase).

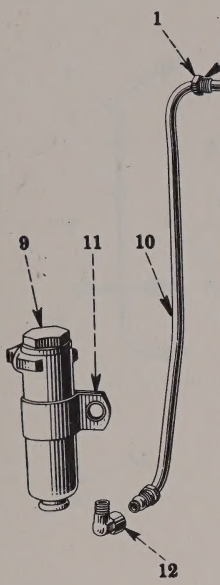
CROSS SHAFT AND CONTROLS

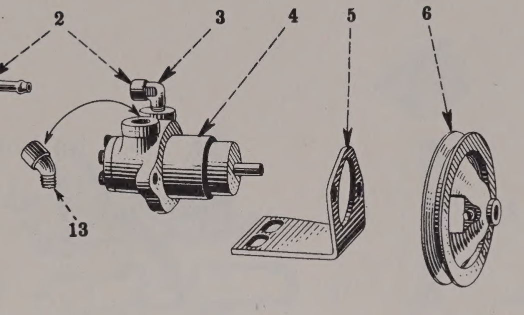


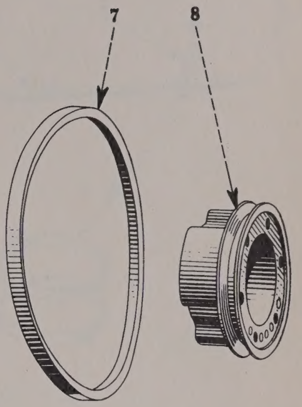
Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

REF. No.	PART No.	DESCRIPTION
1	56462 D	Cross shaft operating lever.
2	20586 D	Cross shaft operating lever pin.
. .	. . . .	One hex. nut, 5/16″ N.F.
. .	. . . .	One lock washer, 5/16″.
3	8525 DA	Cross shaft bracket.
. .	. . . .	Two cap screws, 3/8″ N.C. x 2½″.
. .	. . . .	One cap screw, 3/8″ N.C. x 1⅜″.
. .	. . . .	Three lock washers, 3/8″.
. .	. . . .	One oval point headless set screw, 3/8″ N.C. x 1″.
. .	. . . .	One hex. jam nut, 3/8″ N.C.
4	50827 D	Cross shaft bushing.
5	56460 D	Control cross shaft.
7	52626 D	Cross shaft jaw lever.
8	8721 D	Cross shaft jaw.
. .	. . . .	One oval point headless set screw, 5/16″ N.C. x 1¼″.
. .	. . . .	One hex. jam nut, 5/16″ N.C.
. .	. . . .	One cotter, ⅛″ x 1″.
9	. . . .	One washer, 21/32″ I.D. x 1″ O.D.
10	8617 DX	Cross shaft latch bracket.
. .	. . . .	One flat point set screw, 3/8″ N.C. x 1½″.
. .	. . . .	One hex. jam nut, 3/8″ N.C.
11	56463 D	Carburetor control rod.
. .	. . . .	Two cotters, 1/16 x 7/16″.
12	52624 D	Cross shaft latch spring.
13	55354 DA	Cross shaft latch pin.
14	52621 DX	Cross shaft latch.
15	19306 D	Cross shaft operating rod pin.
. .	. . . .	One cotter, 3/32 x ½″.
16	56457 DA	Cross shaft release lever.
17	56459 DAX	Cross shaft operating rod.
. .	. . . .	One hex. jam nut, 7/16″ N.F.
18	20586 D	Cross shaft release lever pin.
. .	. . . .	One hex. nut, 5/16″ N.F.
. .	. . . .	One lock washer, 5/16″.
19	10765 V	Cross shaft operating rod upper pin.
. .	. . . .	One cotter, 3/32″ x 5/8″.
20	14611 H	Air valve control rod pin.
. .	. . . .	One cotter, 1/16″ x 7/16″.
21	42780 DX	Air valve control rod.
22	58255 D	Cross shaft operating rod adjusting yoke.
23	17730 D	Air valve control rod yoke.
. .	53643 D	Cross shaft latch bracket stud.

FUEL SUPPLY PUMP AND CONNECTIONS



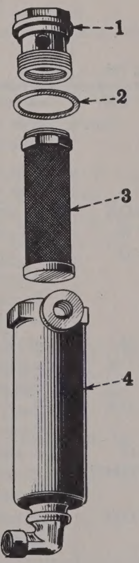




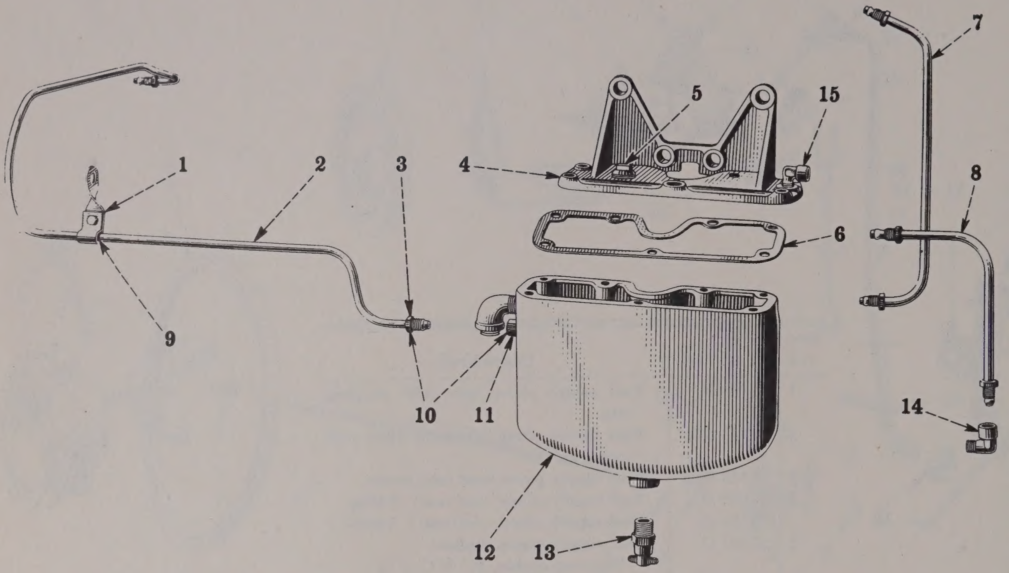
Ref. No.	Part No.	Description
1	37165 D	Fuel supply pump inlet tube coupling nut.
2	37323 DX	Fuel supply pump inlet tube elbow with coupling nut.
3	37323 D	Fuel supply pump inlet tube elbow.
4	{52568 D	Fuel supply pump (optional). Viking.
	}60791 D	Fuel supply pump (optional). Tuthill.
5	52567 D	Fuel supply pump support.
. .	. . . .	Four cap screws, ½″ N.C. x ⅞″.
. .	. . . .	Four lock washers, ½″.
. .	. . . .	Two washers, 17/32″ I.D. x 1″ O.D.
6	8273 DX	Fuel supply pump pulley.
. .	. . . .	One square head cup point set screw, ¼″ N.C. x ⅞″.
. .	. . . .	One hex. nut, ¼″ N.C.
7	49341 D	Fuel supply pump belt.
8	8253 D	Fuel supply pump drive pulley.
. .	. . . .	Six cap screws, ⅜″ N.C. x 2¾″.
9	46636 DA	Supply pump fuel strainer.
10	52566 DX	Fuel supply pump inlet tube with coupling nuts.
11	54873 D	Supply pump fuel strainer bracket.
. .	. . . .	One cap screw, ½″ N.C. x 1½″.
. .	. . . .	One hex. nut, ½″ N.C.
. .	. . . .	One lock washer, ½″.
12	37323 D	Supply pump fuel strainer outlet elbow.
13	51434 D	Injection pump supply tube elbow.

FUEL OIL STRAINER (46636 DA)

Ref. No.	Part No.	Description
. .	**46636 DAX**	**Strainer, with coupling nuts.**
1	60350 D	Plug.
2	60352 D	Gasket.
3	60351 D	Screen assembly.
4	60349 D	Body.



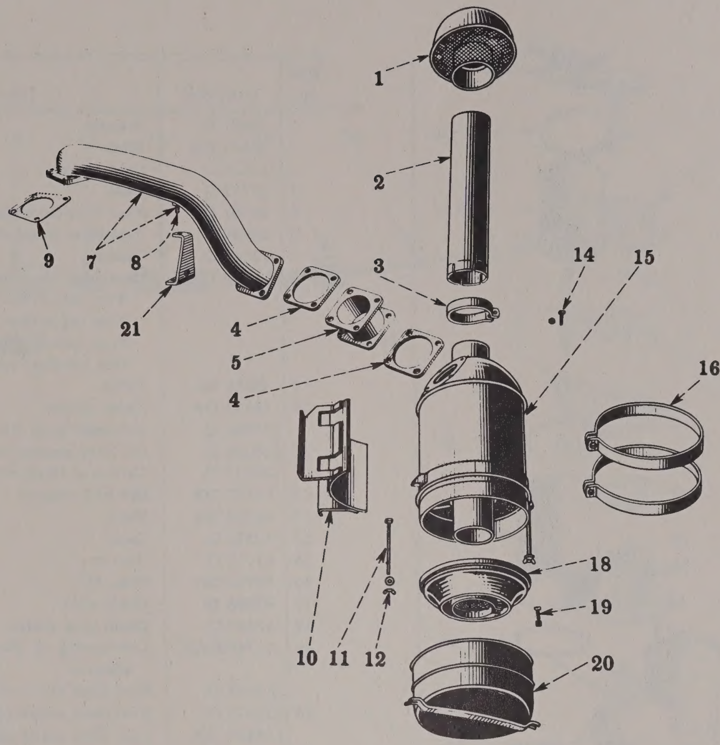
FUEL SUPPLY TANK AND PIPES



Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

Ref. No.	Part No.	Description
1	52565 DX	Fuel tank supply tube clip with washer.
. .	. . . .	One cap screw, 1/4" N.C. x 1/2".
. .	. . . .	One hex. nut, 1/4" N.C.
. .	. . . .	One lock washer, 1/4".
. .	. . . .	One washer, 17/32" I.D. x 1" O.D.
2	52564 DX	Fuel tank supply tube with nuts.
3	37165 D	Tube coupling nut.
4	8272 D	Fuel oil tank cover.
. .	. . . .	Seven cap screws, 3/8" N.C. x 1 1/4".
. .	. . . .	Seven lock washers, 3/8".
5	. . . .	One square head pipe plug, 3/4".
6	52561 D	Fuel oil tank cover gasket.
7	61742 DX	Injection pump return tube with coupling nuts.
8	61741 DX	Primary pump supply tube with nuts (tank to primary pump).
9	26242 D	Fuel tank supply tube clip felt.
10	38026 DMX	Fuel tank supply tube connector with coupling nut.
11	38026 DM	Fuel tank supply tube connector (in fuel oil tank).
12	8271 D	Fuel oil tank.
13	13064 D	Fuel oil tank drain cock.
14	37323 D	Fuel tank to primary pump elbow (in tank).
	37323 DX	Fuel tank to primary pump elbow with nut (in tank).
15	37323 D	Injection pump return tube elbow (in tank).
	37323 DX	Injection pump return tube elbow with nut (in tank).
. .	37323 D	Fuel tank supply tube elbow (in fuel supply pump).
. .	37323 DX	Fuel tank supply tube elbow with coupling nut.
. .	38026 DMX	Primary pump to fuel filter tube connectors with nuts.
. .	38026 DMX	Fuel tank to primary pump connector with nut (in primary pump).

AIR CLEANER

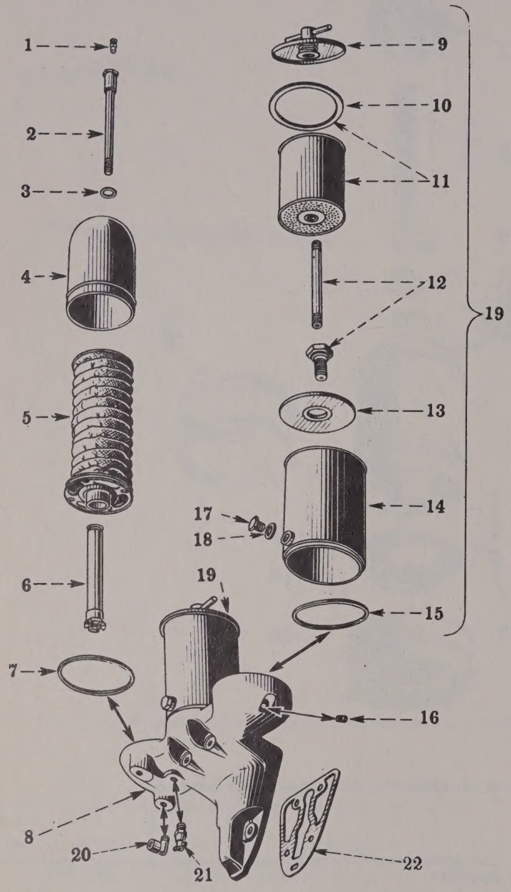


Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

REF. No.	PART No.	DESCRIPTION
. .	**51232 DX**	**Air cleaner (includes Ref. Nos. 11, 12, 13, 15, 16, 17, 18, 19 and 20).**
1	49364 DA	Intake cap.
2	52532 D	Intake pipe.
3	45908 DA	Pipe clamp.
. .	. . . .	One hex. nut, ⅜″ N.C.
. .	. . . .	One lock washer, ⅜″.
4	41637 D	Coupling flange.
. .	. . . .	Four cap screws, ⅜″ N.C. x 1″.
5	41640 D	Pipe coupling.
7	5836 DX	Pipe with stud.
. .	. . . .	Eight cap screws, ⅜″ N.C. x 1¼″.
. .	. . . .	Four lock washers, ⅜″.
. .	. . . .	Four hex. nuts, ⅜″ N.C.
8	41633 D	Pipe brace stud.
. .	. . . .	One hex. nut, ⅜″ N.F.
. .	. . . .	One lock washer, ⅜″.
9	41638 D	Pipe gasket.

REF. No.	PART No.	DESCRIPTION
10	46764 D	Bracket.
. .	. . . .	Four cap screws, ½″ N.C. x 1″.
. .	. . . .	Four lock washers, ½″.
11	. . . .	Two bolts, 5/16″ N.C. x 5½″.
. .	. . . .	Two lock washers, 5/16″.
12	. . . .	Two wing nuts, 5/16″.
14	. . . .	Bolt, ⅜″ N.C. x 1″.
15	45903 DA	Body.
16	41632 D	Bracket band.
. .	. . . .	Two cap screws, 7/16″ N.C. x 2″.
. .	. . . .	Two lock washers, 7/16″.
. .	. . . .	Two hex. nuts, 7/16″ N.C.
18	67119 D	Screen and baffle.
19	. . . .	One fillister head screw, ¼″ N.C. x 1″, and nut.
20	45904 DB	Oil cup.
21	58234 D	Pipe brace.

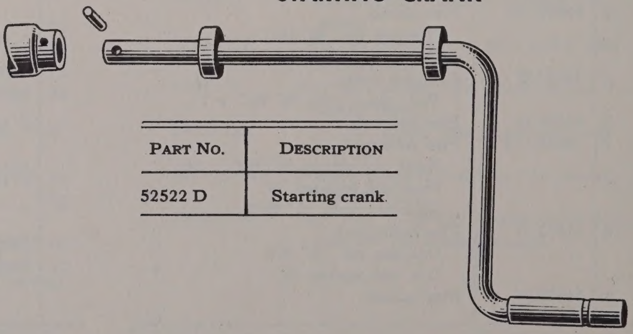
FUEL OIL FILTER
LUBRICATING OIL FILTER



Ref. No.	Part No.	Description
1	39677 D	Bleeder.
2	39577 DA	Stud.
3	13839 D	Stud gasket.
4	28772 D	Case.
5	29501 DA	Fuel filter cloth element.
6	28809 D	Fuel filter metal element.
7	13841 D	Gasket.
8	5990 DAX	Base with bar, adapter and plug.
..	....	Two cap screws, ½" N.C. x 4¾".
..	....	Two cap screws, ½" N.C. x 1½".
..	....	Four lock washers, ½".
..	....	One headless csk. pipe plug, ⅜".
9	42356 DA	Cover.
10	42371 DA	Cover gasket.
11	42366 D	Lubricating oil filter absorption element.
	50308 D	Oil filter element with case cover gasket.
	50310 D	Carton of 10 oil filter elements.
12	41747 DX	Bar and adapter.
13	42369 DA	Plate.
14	42372 D	Case.
15	41746 D	Gasket.
16	50410 DA	Plug, ⅛".
17	42368 D	Drain plug.
18	42367 D	Drain plug gasket.
19	41745 DAX	Lubricating oil filter with bar and adapter.
20	37165 D	Fuel filter pipe nut.
	37323 D	Fuel filter outlet pipe elbow.
	37323 DX	Fuel filter outlet pipe elbow with nut.
21	9982 T	Drain cock.
22	42959 DA	Base gasket.

Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

STARTING CRANK

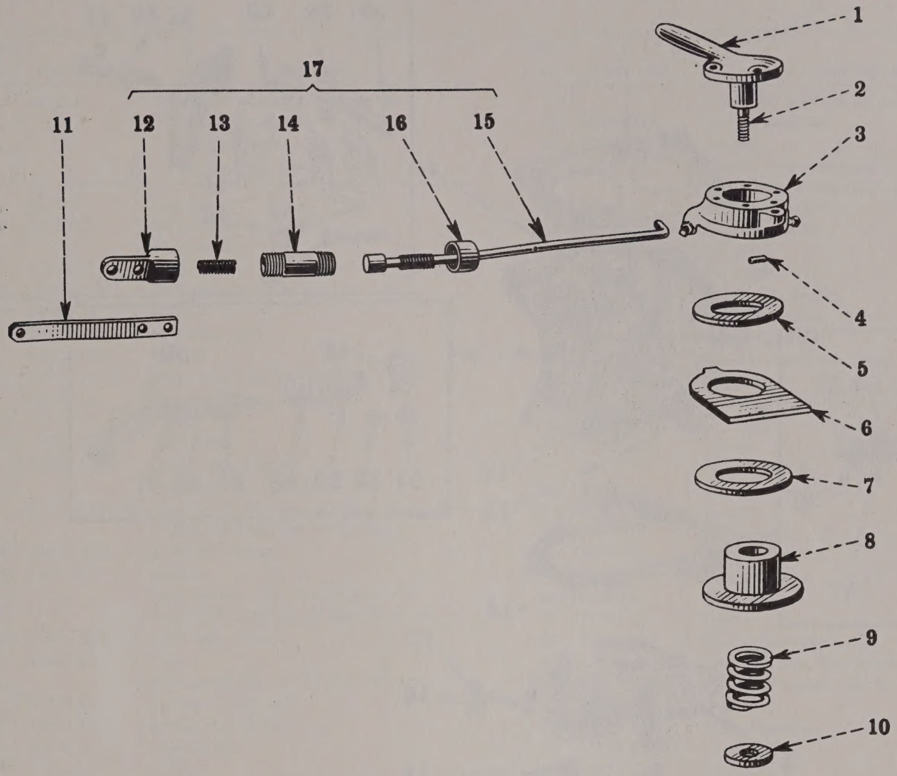


Part No.	Description
52522 D	Starting crank.

ENGINE GASKET PACKAGE

Part No.	Description
52726 D	Engine gasket package.

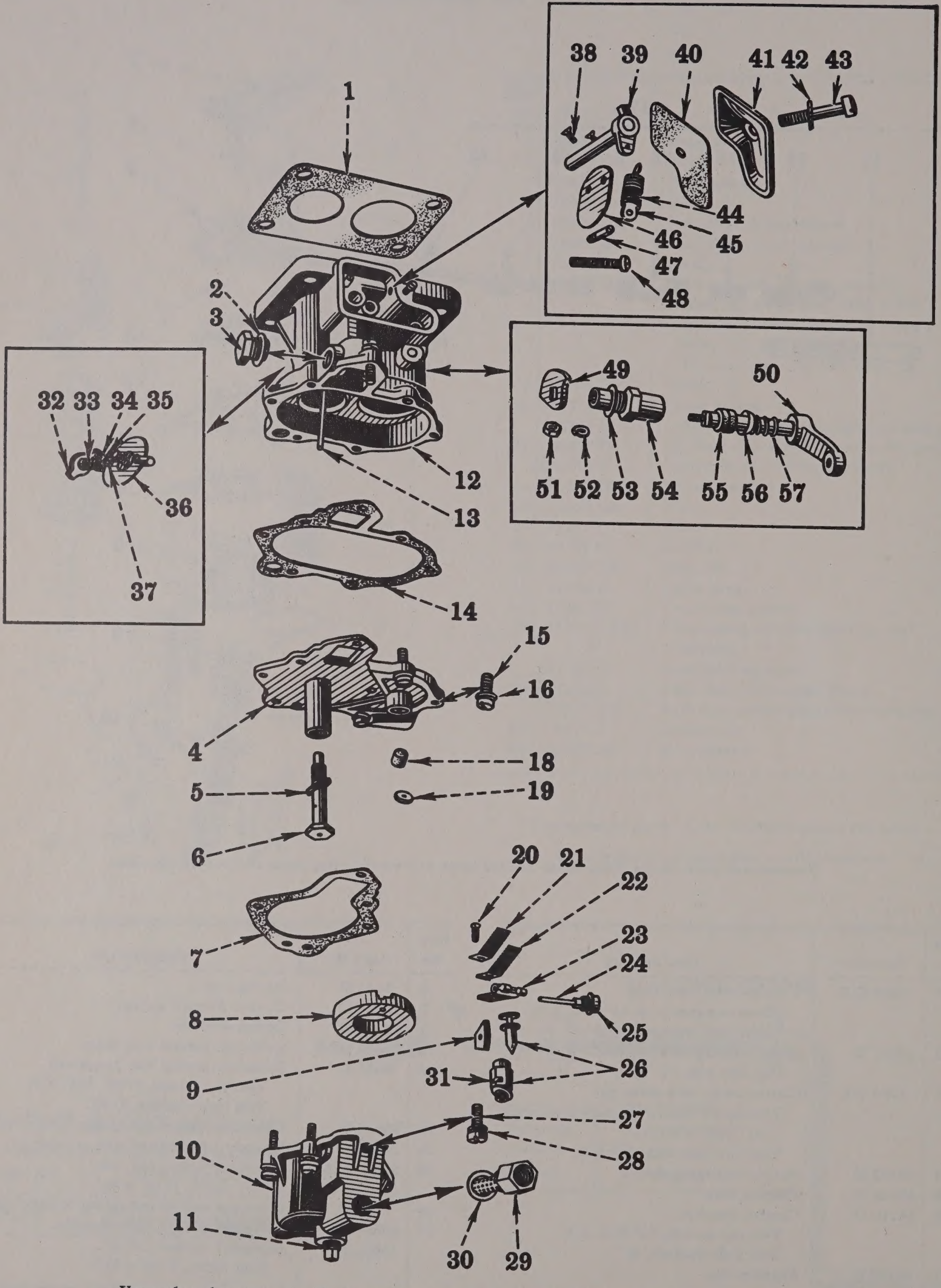
GOVERNOR CONTROL



Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

Ref. No.	Part No.	Description
1	8265 DX	Control lever with stud.
. .	. . . .	Three cap screws, 5/16″ N.C. x ¾″.
. .	. . . .	Three lock washers, 5/16″.
2	52537 D	Control spring retainer stud.
. .	. . . .	One hex. nut, ½″ N.C.
3	8264 DX	Control body with drive pin.
. .	. . . .	Two square head oval point set screws,
. .	. . . .	¼″ N.C. x 1½″.
. .	. . . .	Two hex. jam nuts, ¼″ N.C.
4	39482 D	Spring cup drive pin.
5	48356 D	Friction disc.
6	54210 D	Control bracket.
. .	. . . .	Two cap screws, ⅜″ N.C. x 1″.
. .	. . . .	Two lock washers, ⅜″.
7	48356 D	Friction disc.
8	6649 D	Spring cup.
9	48358 D	Control friction spring.
10	15042 D	Spring retainer.
11	53831 DAX	Governor control rod, front.
12	8655 D	Governor control rod flange cap.
. .	. . . .	Two cap screws, 5/16″ N.F. x ⅝″.
. .	. . . .	Two lock washers, 5/16″.
13	52638 D	Governor control rod spring.
14	52542 D	Governor control rod spring housing.
15	52539 DX	Governor control rod, rear.
. .	. . . .	One cotter, 1/16″ x ⅝″.
16	8266 D	Governor control rod spring housing cap.
17	53832 D	Governor control rod assembly.
. .	14611 H	Governor control rod pin.
. .	. . . .	One cotter, 1/16 x ¾″.

CARBURETOR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Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

CARBURETOR (Continued)

Ref. No.	Part No.	Description
. .	**45163 D**	**Carburetor (Model C-12).**
. .	. . . .	**Four cap screws, ⅜″ N.C. x 1″.**
. .	. . . .	**Four lock washers, ⅜″.**
. .	. . . .	**Four washers, 13/32″ I.D. x ¾″ O.D.**
1	42769 D	Gasket.
2	18377 D	Strainer screen gasket.
		Plug gasket.
3	42844 D	Plug.
4	5050 DX	Bottom plate with plug and filler.
5	32615 D	Gasket.
6	32616 D	Metering well.
7	32606 DA	Gasket.
8	32572 DAX	Float with ferrule.
	53079 D	Float and lever.
9	32574 D	Plate.
10	5051 DX	Fuel bowl.
	35691 DX	Bowl with adapter.
11	. . . .	One steel pipe plug, ⅛″.
12	5049 DAX-32	Body with idle passage plug, idling tube and throttle shaft bushings.
13	32614 DX	Tube with plug.
14	32597 D	Gasket.
15	. . . .	Four screws, No. 12—24 x ¾″.
16	. . . .	Four lock washers for No. 12 screw.
18	27445 DB	Drip hole filler.
19	57957 D	Plug.
20	. . . .	One screw, No. 4—36 x 7/16″.
21	32578 D	Spring, upper leaf.
22	32577 D	Spring, lower leaf.
23	32575 D	Float lever.
24	24672 D	Pivot.
25	32576 DX	Float pivot screw.
26	32581 DXA	Valve cage assembly.
27	. . . .	Four screws, No. 12—24 x 1″.

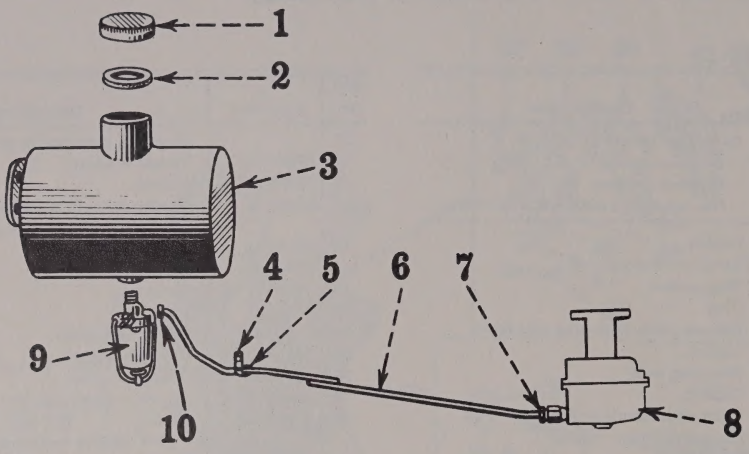
Ref. No.	Part No.	Description
28	. . . .	Four lock washers for No. 12 screw.
29	29902 DX	Screen retainer.
30	18377 D	Gasket.
31	25948 D	Needle valve cage gasket.
		Float lever pivot screw gasket.
32	45161 D	Shaft and lever.
33	27452 D	Packing spring.
34	32590 D	Retainer.
35	14581 D	Packing.
36	32589 DX	Shutter assembly.
37	31636 D	Butterfly screw.
38	14971 D	Butterfly screw.
39	32602 DAX	Throttle shaft assembly.
40	32607 DA	Gasket.
. .	. . . .	One fillister head screw, No. 8—32 x ⅜″.
41	32608 D	Cover.
42	32610 D	Screw gasket.
43	32609 D	Clamp screw.
44	27435 D	Spring.
45	27436 D	Spring end.
46	32601 D	Butterfly.
47	32599 D	Stop pin.
48	32600 D	Stop screw.
49	32582 D	Cam.
50	42871 D	Shaft and lever.
51	. . . .	One hex. nut, No. 8—32.
52	. . . .	One lock washer, No. 8.
53	58836 D	Gasket.
54	32585 DA	Shaft bearing.
55	32588 D	Dust washer.
56	32587 D	Retainer.
57	32586 D	Spring.
. .	41475 D	Choke direction indicator and friction plate.

PRIMER

Ref. No.	Part No.	Description
. .	**32949 DB**	**Starting primer.**
. .	**32949 DBX**	**Starting primer assembly.**
. .	20683 D	Primer inlet pipe connector nut.
. .	20684 D	Primer inlet pipe connector sleeve.
. .	32895 D	Primer inlet tube.
. .	32896 D	Primer inlet tube gland.
. .	32897 D	Primer inlet tube packing.
. . .	32948 D	Primer and inlet valve only.

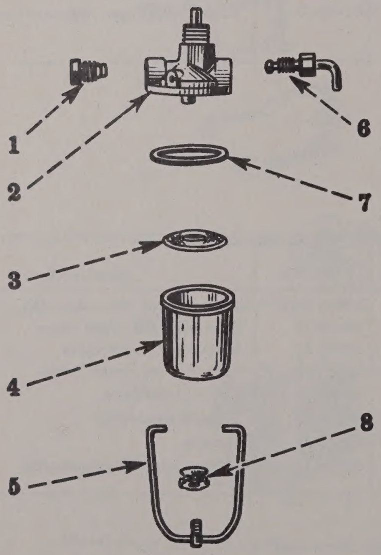
Ref. No.	Part No.	Description
. .	32948 DX	Primer inlet valve assembly.
. .	29836 D	Two balls for check valve.
. .	59880 D	Spring for check valve.
. .	59882 D	Retainer for check valve.
. .	59883 D	Cap nut for tube.
. .	59884 D	Plunger assembly.
. .	59885 D	Handle.
. .	59886 D	Primer inlet valve assembly.

GASOLINE TANK AND CONNECTIONS

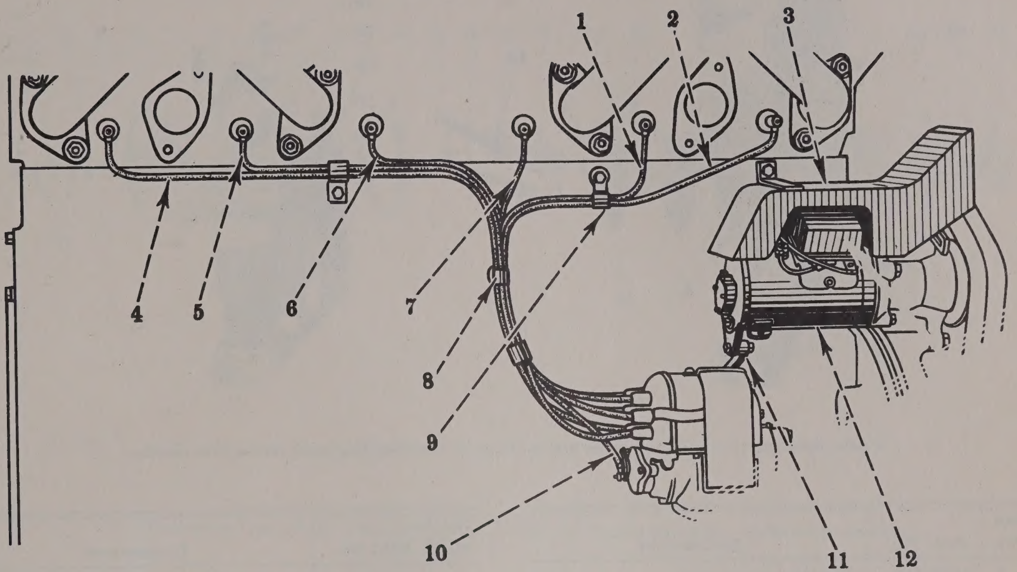


REF. No.	PART No.	DESCRIPTION
1	23995 DA	Cap.
2	23977 DA	Cap gasket.
3	41574 DCX	Gasoline tank, with cap.
. .	. . . .	Four cap screws, 3/8" N.C. x 3/4".
. .	. . . .	Four lock washers, 3/8".
4	23125 D	Gasoline pipe clip.
5	16445 D	Gasoline pipe clip felt.
6	60015 DX	Gasoline pipe.
7	29899 D	Gasoline pipe coupling nut.
8	45163 D	Carburetor.
9	51066 DB	Gasoline strainer.
10	29899 D	Gasoline pipe coupling nut.

GASOLINE STRAINER ASSEMBLY

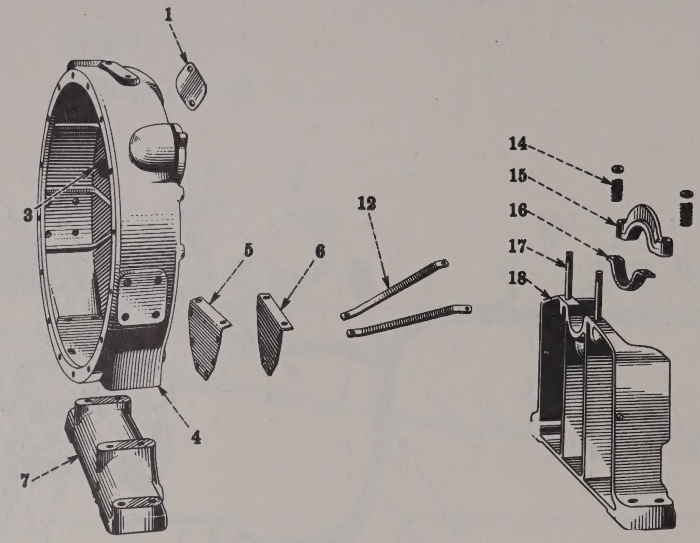


REF. No.	PART No.	DESCRIPTION
. .	**51066 DB**	**Gasoline strainer, less nut.**
. .	**51066 DBX**	**Gasoline strainer, with nut.**
1	29899 D	Coupling nut.
2	54486 D	Top or body.
3	13194 D	Screen.
4	51344 V	Glass.
5	17564 D	Bail or strap.
6	52855 D	Valve.
7	68367 D	Gasket.
8	17565 DA	Nut and cup.



Ref. No.	Part No.	Description
1	42220 D	Cable No. 2.
2	39753 D	Cable No. 1.
3	43006 D	Generator heat shield.
4	29870 D	Cable No. 6.
5	58336 D	Cable No. 5.
6	29128 D	Cable No. 4.
7	28592 D	Cable No. 3.
8	39749 DA	Clip.
. .	. . . .	Cap screw, ⅜″ N.C. x ⅝″.
. .	. . . .	Cap screw, ¼″ N.C. x ⅝″.
. .	. . . .	Lock washer, ⅜″.
. .	. . . .	Lock washer, ¼″.
. .	. . . .	Hex. nut, ¼″ N.C.
9	27387 D	Clip—front.
. .	. . . .	Cap screw, ⅜″ N.C. x ¾″.
. .	. . . .	Lock washer, ⅜″.
10	. . . .	Short circuiting cable.
11	. . . .	Generator bracket.
12	61298 D	Generator.
. .	. . . .	Four cap screws, ⅜″ N.C. x 1¾″.
. .	. . . .	Cap screw, 5/16″ N.F. x 1⅜″.
. .	. . . .	Hex. nut, 5/16″ N.F.
. .	. . . .	Four lock washers, ⅜″.
. .	. . . .	Lock washer, 5/16″.
. .	27618 D	Six cable reinforcements.
. .	37291 D	Six terminals (push type).
. .	42650 DB	Cable assembly.
. .	45578 DA	Spark plug and breaker point gages with ring.
. .	56458 D	Cable clip, rear.
. .	. . . .	Cap screw, ¼″ N.F. x ½″.
. .	. . . .	Hex. nut, ¼″ N.F.
. .	. . . .	Lock washer, ⅜″.
. .	. . . .	Lock washer, ¼″.
. .	1924 T	Six terminals (ring type).

FLYWHEEL HOUSING AND ENGINE SUPPORTS

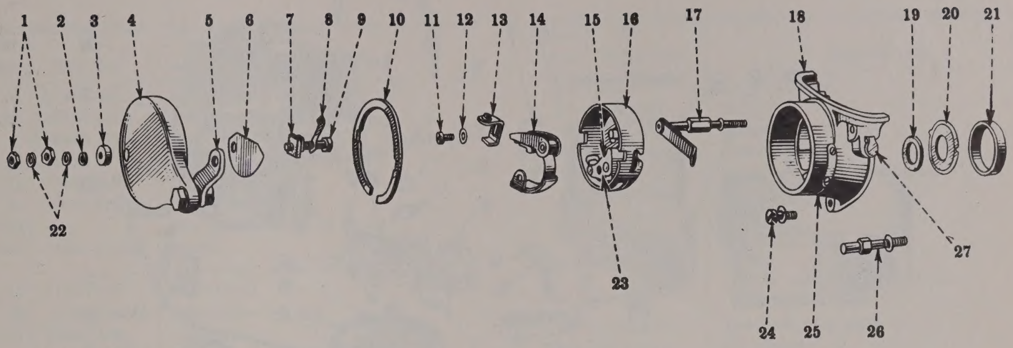


Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

Ref. No.	Part No.	Description
1	25063 DA	Timing mark cover.
. .	. . . .	Two cap screws, 5/16" N.C. x ⅝".
. .	. . . .	Two lock washers, 5/16".
2	29371 D	Starter hole cover.
. .	. . . .	Three cap screws, ⅜" N.C. x ¾".
. .	. . . .	Three lock washers, ⅜".
3	42708 D	Timing indicator.
. .	. . . .	Two flat head rivets, 3/16 x 1¼".
4	8254 D	Flywheel housing.
5	32314 D	Dust seal gasket.
6	32313 D	Dust seal.
. .	. . . .	Six cap screws, ⅜" N.C. x ¾".
. .	. . . .	Two cap screws, ⅜" N.C. x 1¼".
. .	. . . .	Eight lock washers, ⅜".
7	8260 D	Rear support.
. .	. . . .	Four cap screws, ⅝" N.C. x 1½".
. .	. . . .	Four lock washers, ⅝".
. .	. . . .	Four hex. nuts, ¾" N.C.
. .	. . . .	Four lock washers, ¾".
. .	. . . .	Four cap screws, ½" N.C. x ¾".
. .	. . . .	Two cap screws, ½" N.C. x 2".
. .	. . . .	Six lock washers, ½".
. .	. . . .	Two pipes, ½ x 1⅛".
. .	. . . .	Six cap screws, ⅜" N.C. x 1".
. .	. . . .	Two slotted flat head bolts, ⅜" N.C. x 1¼".
. .	. . . .	Two slotted flat head bolts, ⅜" N.C. x 1⅜".
. .	. . . .	Four hex. nuts, ⅜" N.C.
. .	. . . .	Ten lock washers, ⅜".
. .	. . . .	Six washers, 13/32" I.D. x ⅞" O.D.

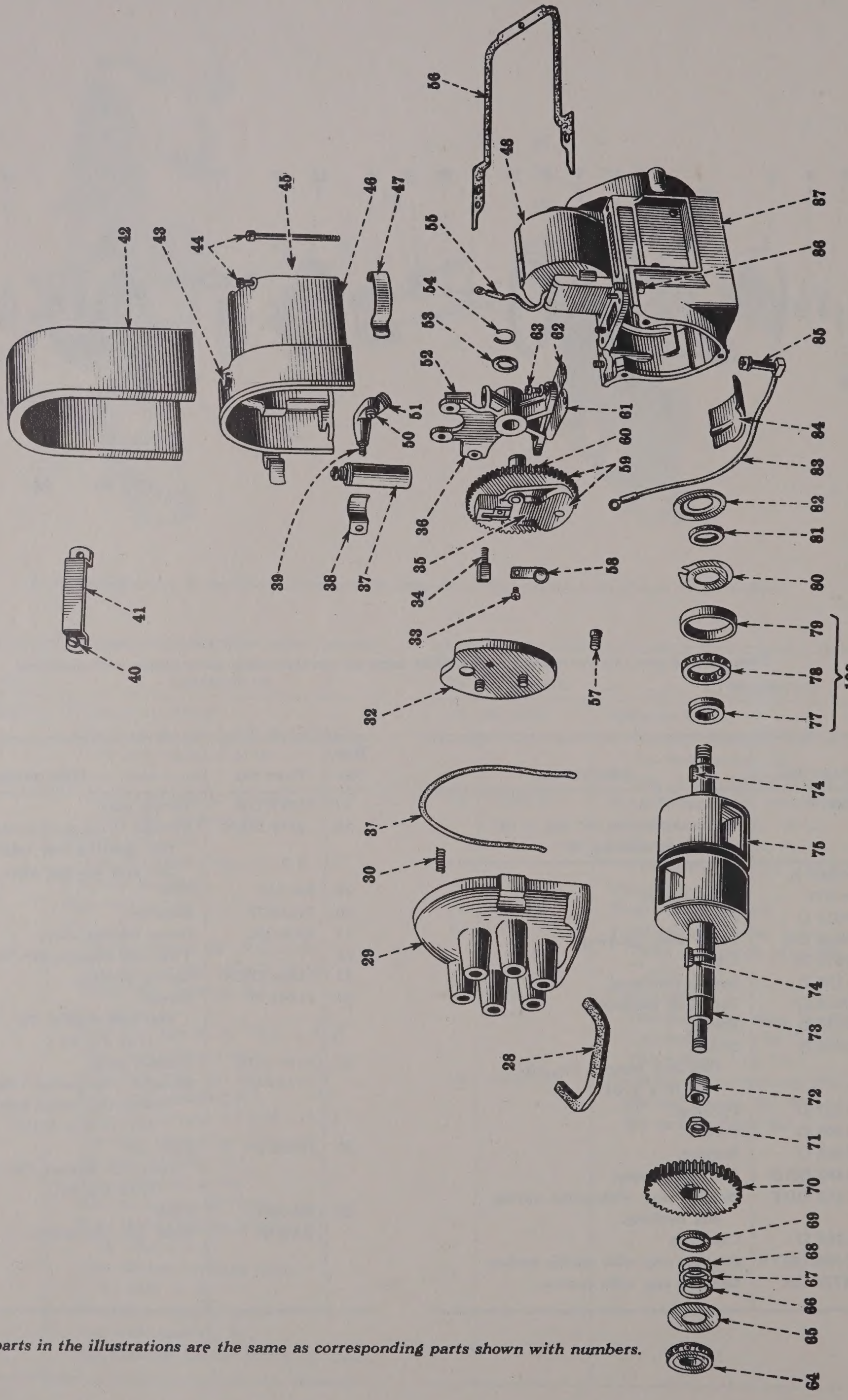
Ref. No.	Part No.	Description
12	52529 D	Radiator brace.
. .	. . . .	One cap screw, ½" N.C. x 1½".
. .	. . . .	One lock washer, ½".
. .	. . . .	One washer, 17/32" I.D. x 1" O.D.
13	21526 D	Hood and radiator brace bolt.
. .	. . . .	Two hex. nuts, ⅜" N.C.
. .	. . . .	Two lock washers, ⅜".
. .	. . . .	Two washers, 13/32" I.D. x ⅞" O.D.
14	28740 H	Clamp spring.
15	8259 D	Front support clamp.
16	52524 D	Front support lining.
. .	. . . .	Three escutcheon pins (No. 11) .120" x ½".
17	28741 H	Clamp stud.
. .	. . . .	Two castle hex. nuts, ⅝" N.F.
. .	. . . .	Two washers, 21/32" I.D. x 1¼" O.D.
. .	. . . .	Two cotters, ⅛ x 1¼".
18	8258 DX	Front support with lining, pins and studs.
. .	. . . .	Six cap screws, ⅝" N.C. x 2¼".
. .	. . . .	Six lock washers, ⅝".

MAGNETO (F-6)



Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

REF. No.	PART No.	DESCRIPTION
. .	**32361 D**	**Magneto (F-6).**
. .	. . . .	**Four cap screws, 3/8" N.C. x 1 5/8".**
. .	. . . .	**Four lock washers, 3/8".**
1	E4-267 A	Nut.
2	E4-271	Plain washer.
3	30037 D	Bushing.
4	3930 DX	Cover with packing.
5	32673 D	Link.
6	31135 D	Spring insulator.
7	30036 D	Terminal insulator.
8	30035 D	Spring.
9	30038 D	Screw.
. .	. . . .	One lock washer, No. 10—1/16 x 3/64".
10	21327 D	Packing.
11	21393 D	Screw.
12	21394 D	Washer.
13	21388 DBX	Stationary point.
14	21373 DBY	Breaker arm with point, spring and bushing.
15	21383 D	Cam felt.
16	21368 DBY6 25796 DA	Breaker cup with spring anchor. Breaker cup with points.
17	21329 DX	Spring post.
18	2548 DAY	Breaker housing with outer race, bearing felt, bearing felt retainer, oiler, oiler felt and breaker stop.
19	E4-226	Felt.
20	21330 D	Retainer.
21	E4A-352	Outer bearing race.
22	. . . .	Two lock washers, No. 10—1/16 x 3/64".
23	21384 DXA	Spring anchor.
24	21441 D	Screw.
. .	. . . .	One lock washer, No. 10—1/16 x 3/64".
25	21443 DX 21444 D	Breaker stop. Breaker stop gasket (not seen).
. .	. . . .	Two slotted round head screws, No. 5—40 x 3/16".
26	28856 D	Link post.
. .	. . . .	One lock washer, No. 10—1/16 x 3/64".
27	E4-295 E4-216	Oiler. Oiler felt (not seen).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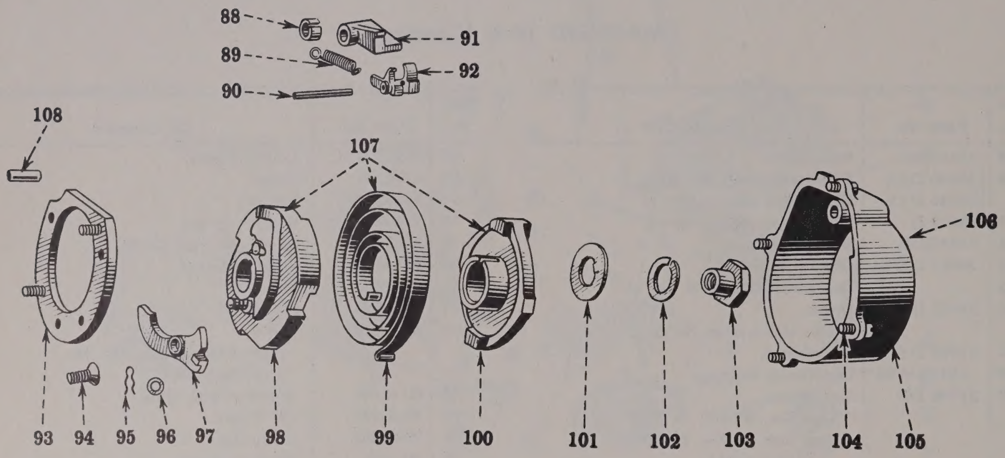
Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

MAGNETO (F-6) (Continued)

REF. No.	PART No.	DESCRIPTION
28	21347 DC	Seal, lower.
29	28656 DZA	Block with seals and disc.
	28656 DYA	Block with seals.
30	28674 D	Distributor contact spring.
31	21348 DB	Seal, upper.
32	28657 DX	Disc.
33	. . . .	One screw, No. 5—40 x 5/16″.
34	21463 DAXA	Brush.
. .	. . . .	One lock washer, No. 6— 1/32 x 1/32″.
35	21460 DY	Distributor.
36	2551 DAY6	Distributor bearing.
37	21409 DB	Condenser.
. .	. . . .	One nut, No. 10—32 N.F.
. .	. . . .	One lock washer, No. 10— 1/16 x 3/64″.
38	21422 D	Clamp.
. .	. . . .	One lock washer, No. 8—3/64 x 3/64″.
. .	. . . .	One fillister head slotted screw, No. 8—32 x 5/16″.
39	21366 D	Spring.
40	21324 D	Screw.
41	21323 D	Strap.
42	21322 D	Magnet.
43	21328 DX	Oiler.
	E4A-576	Oiler felt (not seen).
44	21318 D	Screw, long.
45	E4-295	Oiler.
	E4A-576	Oiler felt (not seen).
46	2547 DX	Cover.
47	21349 D	Spring.
48	21314 DX	Coil core with screws.
	21401 DAX	Coil with end insulators.
	56599 DX	Coil and core with insulators.
	56673 D	Coil end insulator.
50	38609 DA	Plain washer.
51	48564 D	Secondary lead-out.
. .	. . . .	Two fillister head slotted screws, No. 8—32 x ⅝″.
. .	. . . .	Two lock washers, No. 8— 3/64 x 3/64″.
52	38041 D	Felt.
53	21361 D	Washer.
54	21362 D	Snap ring.

REF. No.	PART No.	DESCRIPTION
55	58243 D	Lead-out tube.
56	21319 D	Gasket.
57	28655 D	Screw.
58	21464 DX	Contact spring.
59	21469 D	Shaft, gear and distributor.
60	21360 DX6	Shaft and gear.
61	21353 D	Shim.
62	21466 D	Shim.
63	E4A-358	Screw.
. .	. . . .	Two lock washers, No. 10— 1/16 x 3/64″.
64	E4A-353	Retainer with balls.
65	E4A-324	Oil flinger.
66	E4A-305	Shim, light.
67	E4-212	Shim, medium.
68	E4A-372	Shim, heavy.
69	21340 D	Spacer.
70	33138 D	Pinion (40 teeth).
71	21343 D	Nut.
72	21468 D	Cam.
73	21342 D	Cam key.
74	4167 T	Key (Woodruff No. 3).
75	21333 DX6	Rotor.
76	4167 T	Key (Woodruff No. 3).
77	E4A-351	Inner bearing race.
78	E4A-353	Retainer with balls.
79	E4A-352	Outer bearing race.
80	30379 D	Felt retainer, inner.
81	E4-226	Felt.
82	30378 D	Felt retainer, outer.
83	21399 DX	Primary lead-out.
84	21331 D	Shield.
85	21397 D	Screw.
. .	. . . .	One special heavy lock washer, No. 8— 3/32 x 3/64″.
86	E4A-358	Screw.
. .	. . . .	Two lock washers, No. 10— 1/16 x 3/64″.
87	2546 DBYb	Frame with race, felt, retainers and cover gasket.
. .	. . . .	Two flat head slotted screws, No. 8—32 x 11/16″.

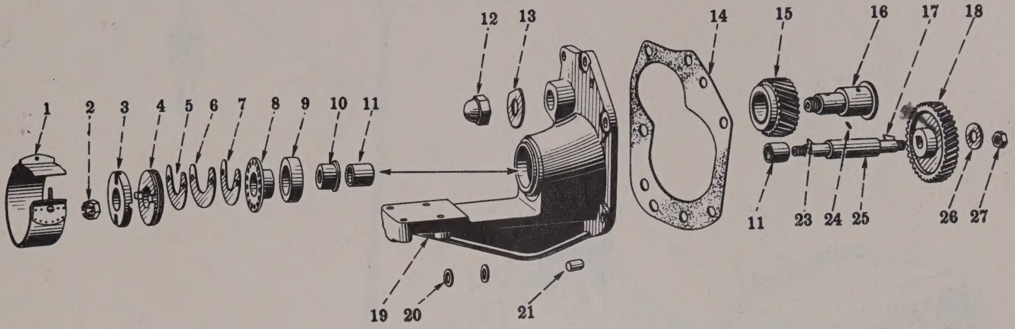
MAGNETO (F-6) (Continued)



Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

Ref. No.	Part No.	Description
88	24616 DA	Pawl spacer.
89	24612 D	Spring.
90	24613 D	Pin.
91	32671 D	Pawl.
92	24611 D	Latch.
93	33150 D	Frame ring.
94	....	Three screws, No. 10—32 x 9/16".
95	30114 D	Snap ring.
96	24610 D	Washer.
97	32711 D	Engaging pawl.
98	32603 DAX	Magneto member with pins.
	32712 D	Magneto member, with pawls.
99	24605 D	Spring.
100	24602 DA	Cam member.
101	24603 D	Washer.
102	....	One lock washer, ½".
103	24604 D	Nut.
104	....	Four screws, No. 8—32 x ⅝".
105	5086 DX	Coupling cover.
..	....	Four lock washers, No. 8.
106	27311 D	Oiler.
107	36246 D	Impulse coupling rotating member, complete.
108	24609 D	Pin.
109	E4-294	Rotor shaft bearing.

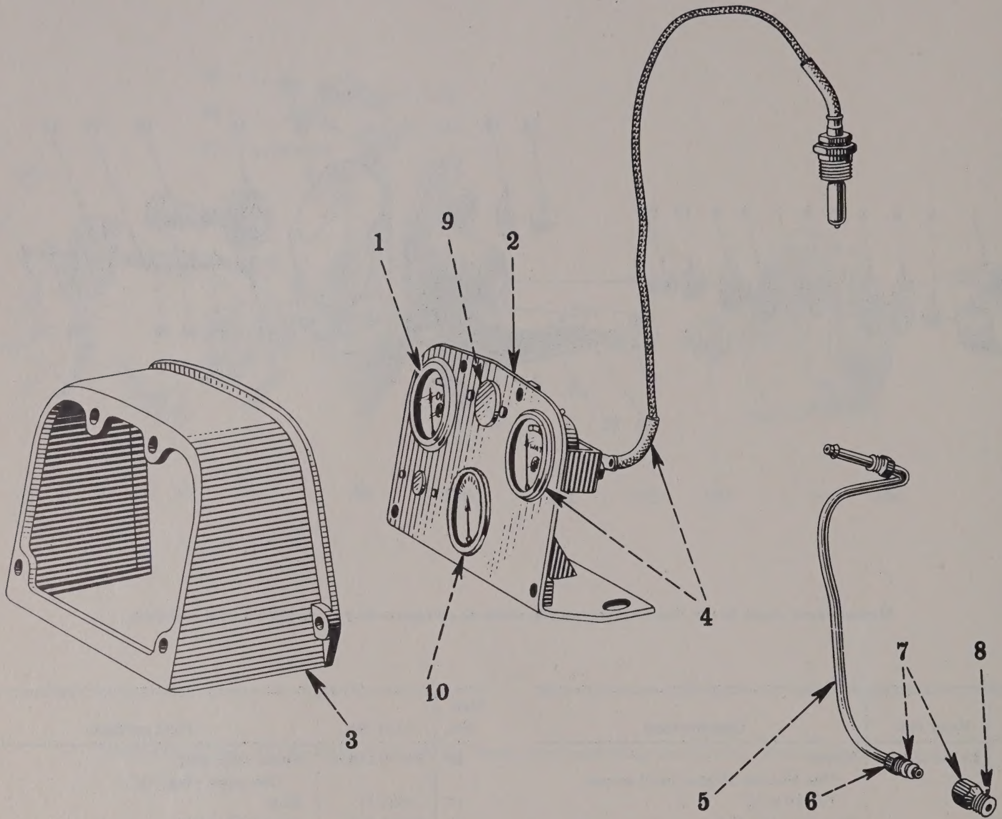
MAGNETO BRACKET AND DRIVE



Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

Ref. No.	Part No.	Description
1	28388 DA	Cover.
. .	. . . .	One slotted fillister head screw, 10—24 x ⅞".
2	. . . .	One nut, ½" N.F.
3	35719 D	Spacer.
4	12740 D	Block (male).
5	10481 D	Shim (medium).
6	10482 D	Shim (heavy).
7	10553 D	Shim (light).
8	22716 D	Coupling.
. .	. . . .	Two cap screws, ¼" N.F. x 7/16".
. .	. . . .	Two lock washers, ¼".
9	33788 D	Oil seal.
10	32503 D	Spacer.
11	32506 D	Bushing.
12	35319 D	Nut.
13	25132 D	Washer.
14	32505 D	Gasket.
15	32497 DX	Gear (27 teeth) with bushing.
16	32499 DAX	Shaft with plug.
. .	. . . .	One pipe plug, ⅛".
17	13085 D	Key.
18	32500 DA	Gear (36 teeth).
19	5947 DX	Bracket with bushings, dowels and plugs.
. .	. . . .	Two pipe plugs, ⅛".
. .	. . . .	Four cap screws, ½" N.F. x 2".
. .	. . . .	One cap screw, ½" N.F. x 2¼".
. .	. . . .	One cap screw, ½" N.F. x 1⅛".
. .	. . . .	Four lock washers, ½".
. .	. . . .	Four hex. nuts, ½" N.F.
20	25352 D	Gasket.
21	32504 D	Dowel.
23	4167 T	Key.
24	29764 D	Pin.
25	32501 D	Shaft.
. .	. . . .	One cotter, 3/32 x 1".
26	32502 D	Washer.
27	. . . .	One nut, ½" N.F.

INSTRUMENT HOUSING AND GAGES

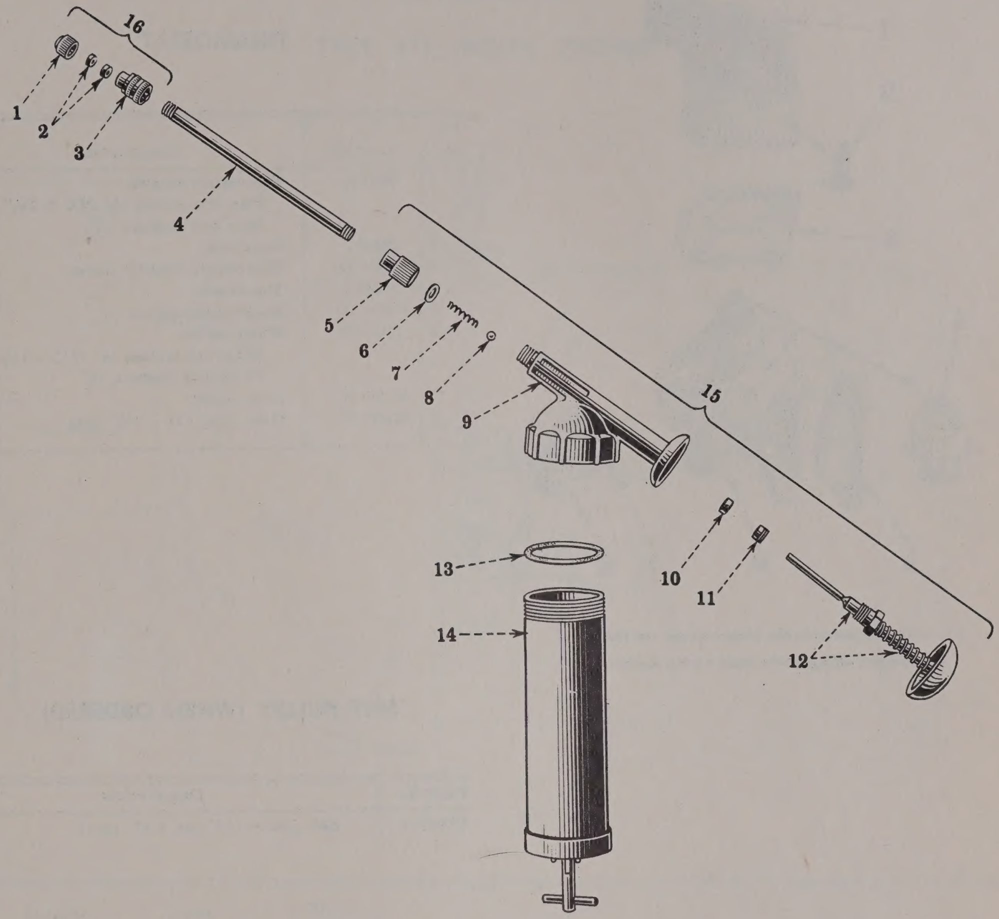


Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

Ref. No.	Part No.	Description
1	67968 DM	Oil pressure indicator with clamp and stud washers.
. .	. . . .	Two hex. nuts, No. 12—24 N.C.
2	55887 DX	Instrument panel.
. .	. . . .	Two cap screws, ½″ N.C. x ⅞″.
. .	. . . .	Two lock washers, ½″.
3	8662 D	Instrument panel housing.
. .	. . . .	Six round head screws, 5/16″ N.C. x ¾″.
. .	. . . .	Six lock washers, 5/16″.

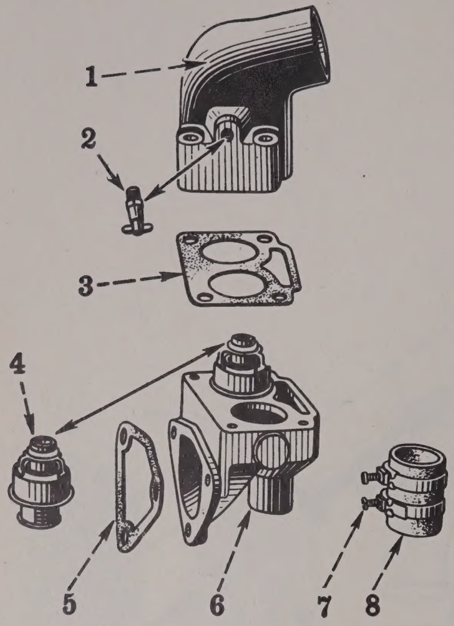
Ref. No.	Part No.	Description
4	67873 DM	Heat indicator.
5	52544 DX	Oil pressure indicator tube with nuts.
6	29898 D	Oil pressure indicator tube coupling nut.
7	59730 HX	Oil pressure indicator tube half union with coupling nut.
8	59730 H	Oil pressure indicator tube half union.
9	64931 H	Starter switch.
10	42383 D	Ammeter.

LUBRICATOR



Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

REF. No.	PART No.	DESCRIPTION
	Q 3794	**Lubricator (9 oz. capacity).**
1	39653 D	Nozzle cap.
2	39656 DX	Washer (set of 2).
3	39652 D	Nozzle body.
4	. . . .	Standard pipe, 6″.
5	39875 D	Adapter.
6	39655 D	Gasket.
7	39870 D	Check spring.
8	39659 D	Check ball.
9	39868 D	Pump body.
10	39665 D	Packing.
11	39651 D	Packing screw.
12	39663 D	Plunger assembly.
13	39654 D	Gasket.
14	39661 D	Tube assembly.
15	39662 D	Head assembly.
16	39800 D	Nozzle.
	39800 DX	Nozzle, with extra set of washers.



Unnumbered parts in the illustrations are the same as corresponding parts shown with numbers.

THERMOSTAT

Ref. No.	Part No.	Description
1	5952 D	Thermostat housing.
..	....	Four cap screws, ½″ N.C. x 2½″.
..	....	Four lock washers, ½″.
2	9982 T	Vent cock.
3	37634 D	Thermostat housing gasket.
4	37634 D	Thermostat.
5	42654 D	Water outlet gasket.
6	5951 D	Water outlet.
..	....	Three cap screws, ½″ N.C. x 1½″.
..	....	Three lock washers, ½″.
7	91406 H	Hose clamp.
8	42656 D	Hose, 1¾″ I.D. x 2¾″ long.

BELT PULLEY (WHEN ORDERED)

Part No.	Description
52569 D	Belt pulley (12″ dia. x 15″ face).

TOOLS — WHEN ORDERED (55155 D)

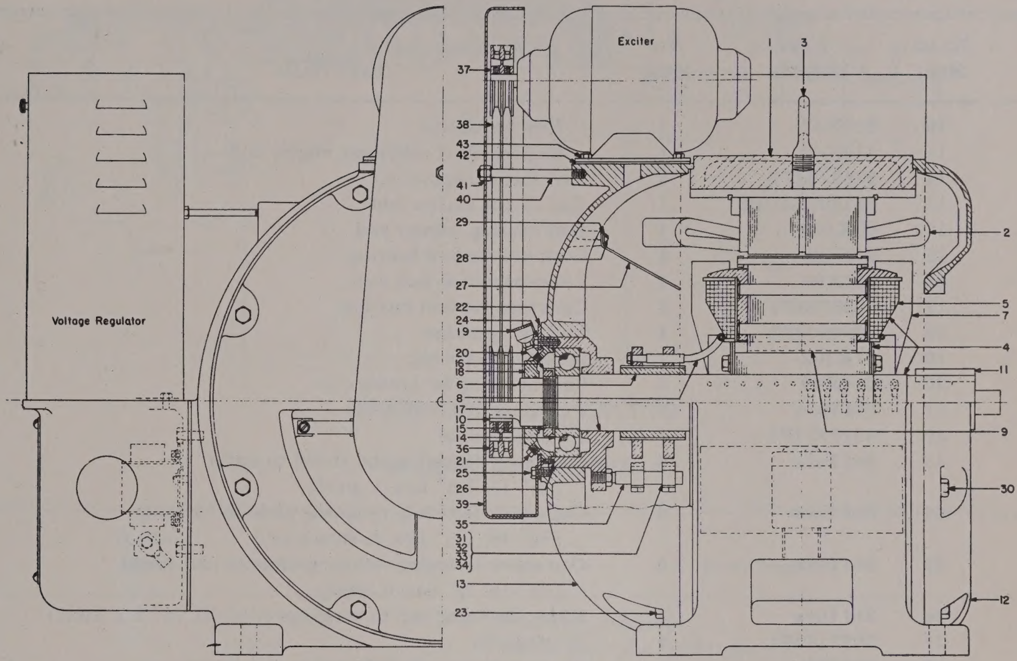
Part No.	Description
11858 DA	Water pump wrench.
19289 D	Hexagon socket wrench (9/16″).
19291 D	Hexagon socket wrench (⅝″).
19292 D	Hexagon socket wrench (¾″).
19323 D	Socket wrench handle (combination offset and tee).
19324 D	Hexagon socket wrench (⅞″).
19325 D	Hexagon socket wrench (13/16″).
19326 D	Hexagon socket wrench (1″).
19327 D	Hexagon socket wrench (1⅛″).
19328 D	Socket wrench carrying case.
19329 D	Socket wrench set (in carrying case).

Part No.	Description
20156 D	Square socket wrench (½″).
20157 D	Square socket wrench (11/16″).
25462 DA	Stem handled socket wrench (1-1/32″).
25463 D	Stem handled socket wrench handle.
25466 D	Spark plug wrench handle.
32941 D	Spark plug wrench (31/32″).
8 E	12″ adjustable steel wrench.
H 156	Oil can.
Q 3794	Lubricator (9 oz. capacity). (*See detail list on page ...*)
2587 T	Pliers.
2588 T	Screw driver.

PARTS LIST

ALTERNATOR

TYPE ATI, MODEL 12G308



Exciter
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ILLUS. REF.	PART NUMBER	NO. REQ.	PART NAME
	12G308	1	Type ATI Alternator, complete
1	8134280G1	1	Stator with winding and leads
2	214X45	72	Stator coil with slot insulation and wedges
*	8139116G2	4	Terminal for lead
3	Std Hdw	1	Eyebolt for stator (1¼″-7 steel)
4	8134273G1	1	Rotor with coils, shaft, collector, and fan
5	8134334G1	6	Rotor coil with pole piece and amortisseur winding
6	5856196G3	1	Collector
7	5865984ABG5	6	Fan
*	Std Hdw	12	Cap screw fastening fan to rotor (½″-13, 1″ hex. h. steel)
*	Std Hdw	12	Lockwasher for ½″ screw
8	5856427G1	1	Set of two rotor leads
9	214X46	6	Rotor pole key

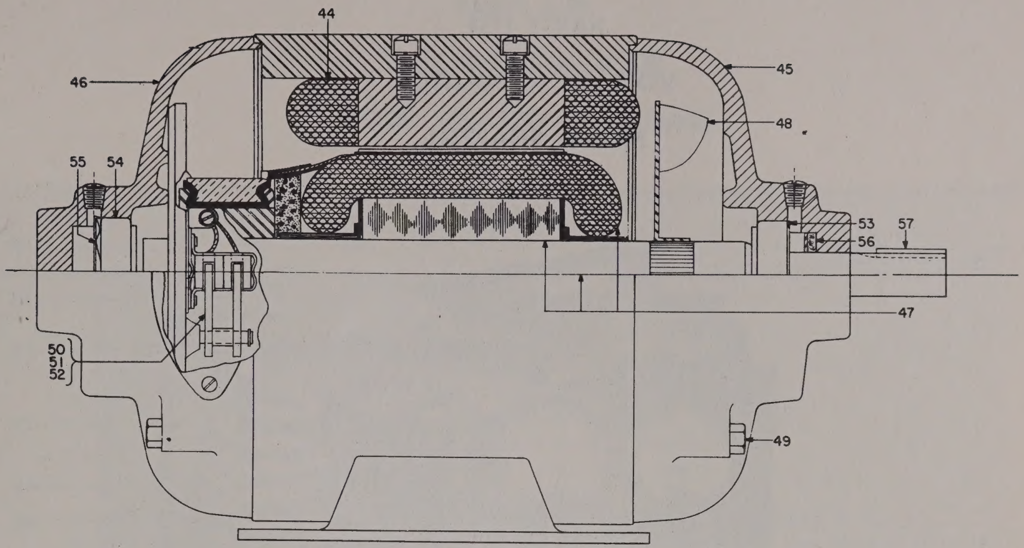
PARTS LIST

ALTERNATOR

TYPE ATI, MODEL 12G308 (Continued)

Illus. Ref.	Part Number	No. Req.	Part Name
10	214X47	1	Key for sheave
11	214X48	1	Key for shaft extension, engine end
12	5888703P1	1	End shield, engine end
13	5818955ABP1	1	End shield, exciter end
14	60X440	1	Ball bearing, exciter end
15	213X89	1	Lock nut for ball bearing
16	213X90	1	Lockwasher for lock nut
17	5888705P1	1	Cartridge for ball bearing
18	5848564P1	1	Cap for cartridge
19	87X102	1	Grease cup for cap
20	214X49	1	Grease fitting for grease cup
21	Std Hdw	1	Pipe plug (¼″ st'd steel)
22	4318922P1	1	Retaining plate
23	Std Hdw	8	Cap screw fastening end shield to stator (⅝″-11, 2½″ hex. h. steel)
24	Std Hdw	6	Cap screw fastening retaining plate to cartridge (⅜″-16, 1¼″ hex. h. steel)
25	Std Hdw	6	Cap screw fastening retaining plate to end shield (⅜″-16, ¾″ hex. h. steel)
26	Std Hdw	3	Screw fastening cap to cartridge (¼″-20, ¾″ f. h. steel)
27	5857146P1	1	Air deflector
28	Std Hdw	4	Screw fastening air deflector to end shield (5/16″-18, ⅝″ r. h. steel)
29	Std Hdw	4	Lockwasher for 5/16″ screw
30	Std Hdw	8	Cap screw fastening end shield, engine end, to stator (⅝″-11, 2½″ hex. h. steel)
31	5844427ABG1	4	Brush holder with brush-holder body, tension spring, and pressure arm
32	243928	4	Tension spring
33	1846460G1	4	Pressure arm
34	5804490	4	Carbon brush with pigtail and terminal
35	5823467ADG1	1	Brush-holder stud with insulation, bushings, and lock nut
36	5867848G1	1	Sheave for generator
37	5867890G1	1	Sheave for exciter
38	5871222	1	Set of two matched belts
39	5857144G1	1	Belt guard
40	5857238P74	1	Stud for belt guard
41	Std Hdw	2	Nut for stud (½″-13, hex. steel)
42	5837919	1	Shim for exciter
43	Std Hdw	4	Cap screw fastening exciter to end shield, exciter end (⅜″-16, 1″ hex. h. steel)

**Not shown in illustration*



PARTS LIST — D-C EXCITER

MODEL 5BC78DB2A

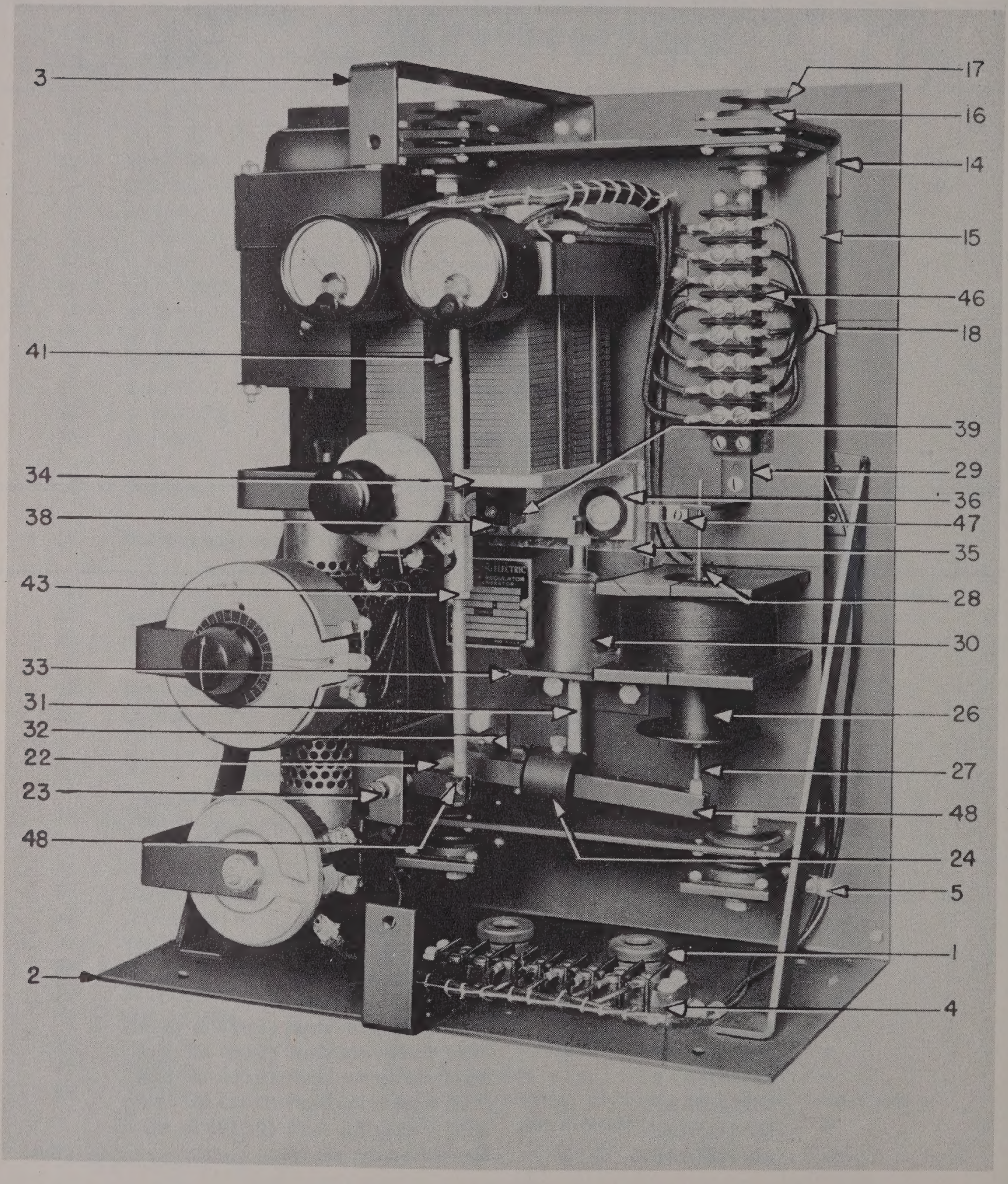
Illus. Ref.	Part Number	No. Req.	Part Name
	5BC78DB2A	1	D-C exciter, complete
*	214X50	1	Set of two main field coils
44	214X51	1	Commutating field coil
45	8114516AAP1	1	End shield, pulley end
46	4267550GAG1	1	End shield, commutator end
47	214X52	1	Armature
48	8132149ACG1	1	Fan for armature
49	5895821AAG3	8	Clamping bolt for end shield
50	8104785AAG2	4	Carbon brush with pigtail and terminal
51	8104782AAG2	1	Brush-holder yoke with brush holders and pressure springs
52	5023472	4	Pressure spring
*	5073650	1	Capacitor
53	5855279ACP2	1	Ball bearing, pulley end
54	5855279ACP1	1	Ball bearing, commutator end
55	5859944AAP1	1	Spring washer for shaft
56	5859706AAP1	1	Felt washer for shaft
*	5855416AAP2	1	Steel washer for shaft (0.025 in. thick)
*	5855415AAP5	1	Steel washer for shaft (0.062 in. thick)
*	5855415AAP1		Steel washer for shaft (0.006 in. thick)
*	5855415AAP2		Steel washer for shaft (0.015 in. thick)
*	5855415AAP3		Steel washer for shaft (0.0185 in. thick)
57	5826928AAP17	1	Key for exciter sheave

**Not shown in illustration*

PARTS LIST

VOLTAGE REGULATOR

MODEL 3GA37G1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PARTS LIST

VOLTAGE REGULATOR

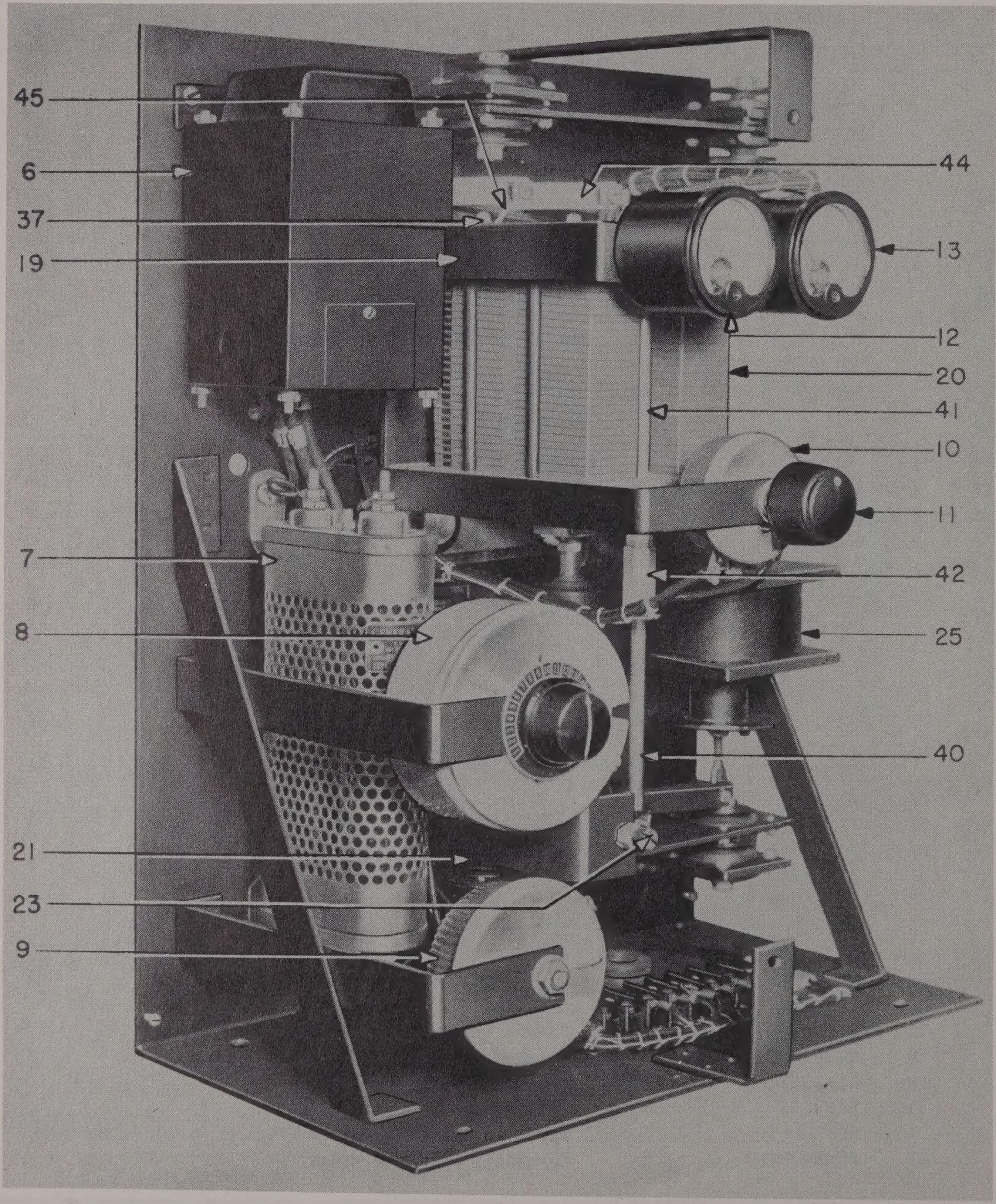
MODEL 3GA37G1 (Continued)

Illus. Ref.	Part Number	No. Req.	Part Name
	3GA37G1	1	Regulator, complete
	8240366G1	1	Cover, complete
	5957898	2	Knurled screw fastening cover in position
	8240366P13	1	Glass window for cover
	1307939	1	Rubber bushing in cover for rheostat
1	1314323	2	Rubber bushing in base for leads
2	8282307G1	1	Base with supports
3	8278949	1	Bracket for cover
	129677	2	Screw fastening bracket to base (10-24, ½ in. r.h.)
4	8068582P6	1	Terminal board
	128617	4	Screw fastening terminal board to base (8-32, ⅝ in. r.h.)
5	7875288	2	Cleat for leads
	144069	2	Screw fastening cleat to base (8-32, ¼ in. r.h.)
6	71G21	1	Potential transformer
	129677	3	Screw fastening transformer to base (10-24, ½ in. r.h.)
7	3887742G7	1	Resistor, 60 ohms
	129677	2	Screw fastening resistor to base (10-24, ½ in. r.h.)
8	89X535	1	Exciter field rheostat
9	98X393	1	Compensating rheostat
10	5971008G5	1	Voltage adjusting rheostat
11	6910554	1	Knob for rheostat
	7861546P7	1	Set screw for knob
12		1	Voltmeter, Model 8AW40VY12 (0-150 volts) scale 0-300
13		1	Ammeter, Model 8AW40ABR1Y, 5 amperes, transformer rated, scale 0-200
14	6910563P5	1	Support for regulator base
	20X529	8	Screw fastening support to base (¼ in.-20, ⅝ in. h.h.)
15	8082309	1	Base for regulator
16	98X381	8	Rubber mounting for base
17	6900865	12	Washer for rubber mounting
	20X556	4	Screw for rubber mounting and base (¼ in.-20, 1¾ in. h.h.)
	154929	16	Screw fastening rubber mounting to base (6-32, ¼ in. r.h.)
	31X925	16	Screw fastening rubber mounting to support (6-32, 5/16 in. r.h.)
18	399368	1	Rubber bushing in base for connection leads
19	8278945	1	Support for voltmeter and ammeter
20	5188857G1	1	Resistance stack
21	5188811	1	Support for operating shaft
	20X529	2	Screw fastening support to base (¼ in.-20, ⅝ in. h.h.)
22	4968929G1	1	Operating shaft with levers

PARTS LIST

VOLTAGE REGULATOR

MODEL 3GA37G1 (Continued)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PARTS LIST

VOLTAGE REGULATOR

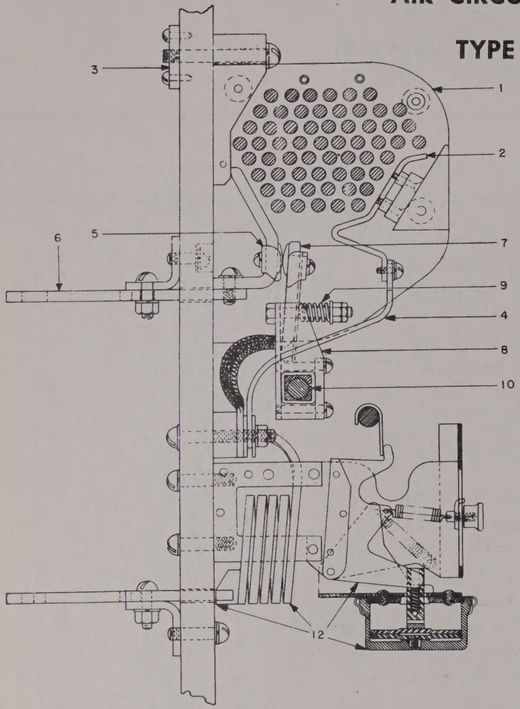
MODEL 3GA37G1 (Continued)

ILLUS. REF.	PART NUMBER	NO. REQ.	PART NAME
23	5159501	1	Pivot screw for operating shaft
24	5159539	1	Weight for operating lever
	20X532	1	Set screw for weight
25	4961114G2	1	Operating coil
26	5184595G2	1	Core for operating coil
27	5156914	1	Pin for core and lever
28	5157672	1	Core stem
29	5157662	1	Core guide
	129677	1	Screw fastening guide to base (10-24, ½ in. r.h.)
30	4954142G1	1	Buffer
31	5159525	1	Operating rod for buffer
32	5184518G1	1	Spring for operating rod
33	5188810	1	Support for buffer
	20X529	2	Screw fastening support to base (¼ in.-20, ⅝ in. h.h.)
34	5188812G1	1	Support for resistance stack
35	5184508	1	Insulation between support and base
	64X695	2	Screw fastening support to base (¼ in.-20, 1 in. h.h.)
36	5159516	2	Insulation washer for screw
	5159515	2	Bushing for screw
	5188800G1	2	Top plate for resistance stack
	5184598G2	1	Front compression plate with tips for resistance stack
	5184598G1	1	Rear compression plate with tips
37	5304098	4	Tip for compression plate
	5357384	4	Locking ring fastening tip to compression plate
	5159503	1	Shaft for compression plate
38	5357345	1	Torsion spring for shaft
39	5159506	1	Insulation block for spring
	129846	2	Screw fastening spring to block (8-32, ½ in. r.h.)
	144069	2	Screw fastening block to base (8-32, ¼ in. r.h.)
40	5156921	1	Lower connection rod
41	5159543	1	Upper connection rod
42	5152807	1	Connection nut for connection rod
43	5156939	1	Lower lock nut for connection nut
44	6900847	2	Connection post
45	5184599G4	2	Flexible connection for resistance stack
	62X597	2	Screw fastening flexible connection to top plate (10-32, 3/16 in. r.h.)
46	8068582P6	1	Terminal board
	61X597	2	Screw fastening terminal block to base (10-32, ¾ in. fill.h.)
47	463327	1	Cleat for leads
	144069	1	Screw fastening cleat to base (8-32, ¼ in. r.h.)
	89X709	14	Terminal
48	5156914	4	Pin for operating lever

PARTS LIST

AIR CIRCUIT BREAKER

TYPE AE-1A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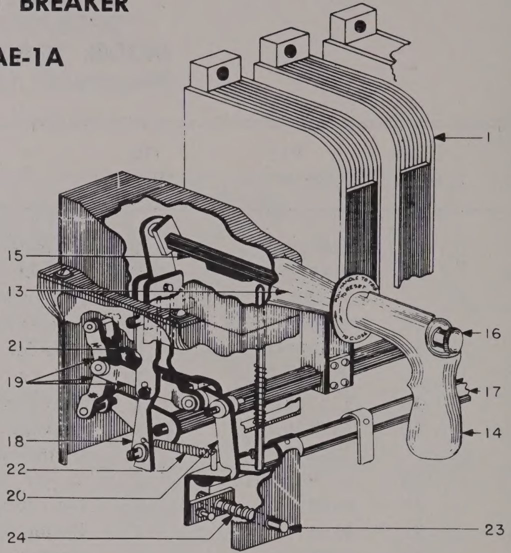
Pole Unit
Parts List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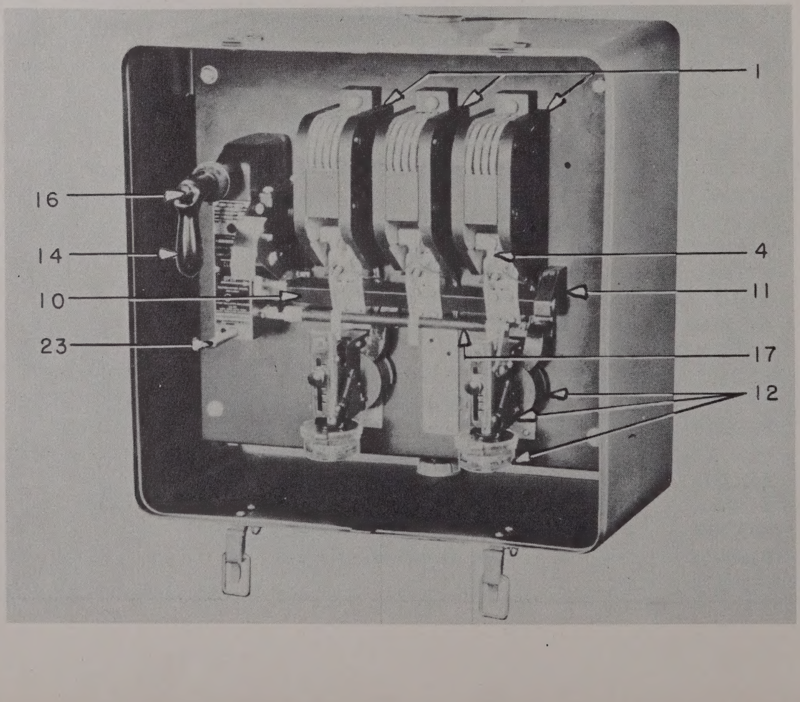
Manual Operating Mechanism
Parts List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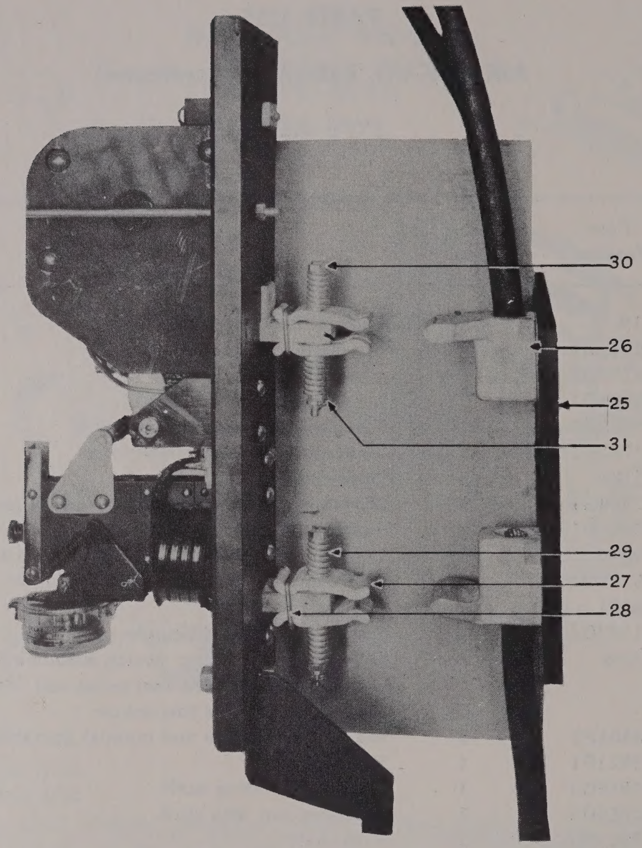
PARTS LIST

AIR CIRCUIT BREAKER (Continued)

TYPE AE-1A

Illus. Ref.	Part Number	No. Req.	Part Name
	AE-1A		Air Circuit Breaker, Complete
1	6125645G1	3	Arc chute, complete
2	6175277G1	3	Arcing horn
3	6275605G1	3	Locking plate for arc chute
4	6175462G1	3	Connection strip for arcing horn
5	6201722G1	3	Stationary contact with support
6	6241185	3	Upper stud
7	6212564G1	3	Movable contact with flexible connection
8	6175991G1	3	Support for movable contact
9	6079844	3	Compression spring for movable contact
10	6175279G1	1	Crank and shaft for movable contact
11	6145391	1	Bearing for shaft
	6271187G1	1	Lower stud for middle pole
12	282X48	2	Dual overcurrent trip device, assembled complete, with magnet, lower stud and series coil. Renewal parts are not furnished for this device
13	6115501P2	1	Support for handle and manual operating shaft
14	6175021P1	1	Handle
15	6201618G1	1	Manual operating shaft
16	6212386G3	1	Insulated nut with stud
17	6175281G1	1	Trip shaft
18	6175272G1	1	Prop
19	6115543G2	1	Toggle mechanism
20	6115543G1	1	Toggle mechanism with latch
21	6145410	2	Toggle link
22	6079812	1	Latch spring
23	6241084	1	Manual trip button
24	6074299	1	Spring for manual trip button
	6115470G2	1	Shunt trip device (not illustrated)
	22D3G55	1	Operating coil for shunt trip device, 120 volts, 60 cycles
	6212554G1	1	Auxiliary switch with base and contacts (not illustrated)



PARTS LIST

AIR CIRCUIT BREAKER (Continued)

TYPE AE-1A

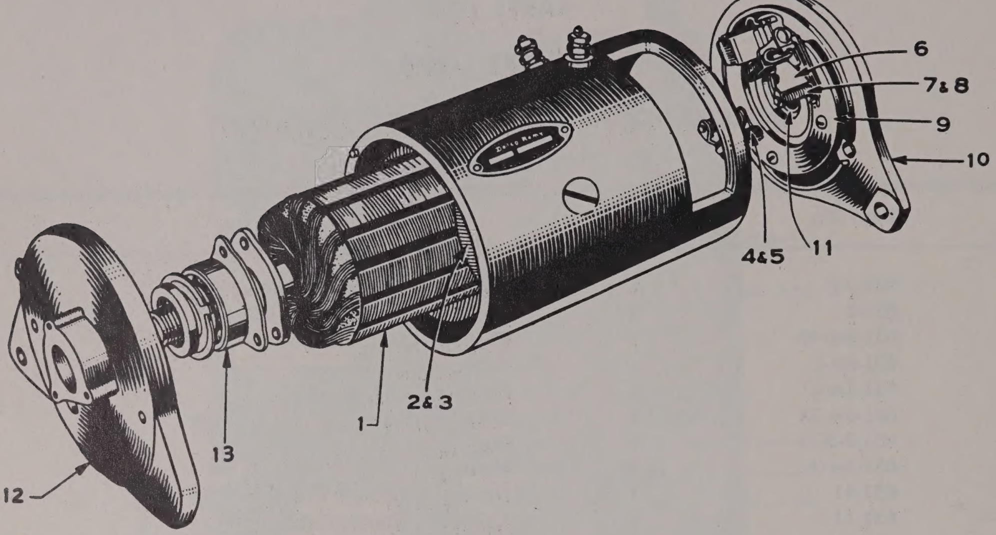
ILLUS. REF.	PART NUMBER	NO. REQ.	PART NAME
			STATIONARY CONTACT SUPPORT
25	631A	1	Stationary contact support
26	631B	3	Stationary contact
27	631C	6	Finger contact
28	631D	3	Finger clip
29	631E	6	Spring
30	631F	3	Bolt
31	631G	3	Adjusting nut

PARTS LIST

GENERAL ITEMS

INTERNATIONAL DIESEL ELECTRIC COMPANY

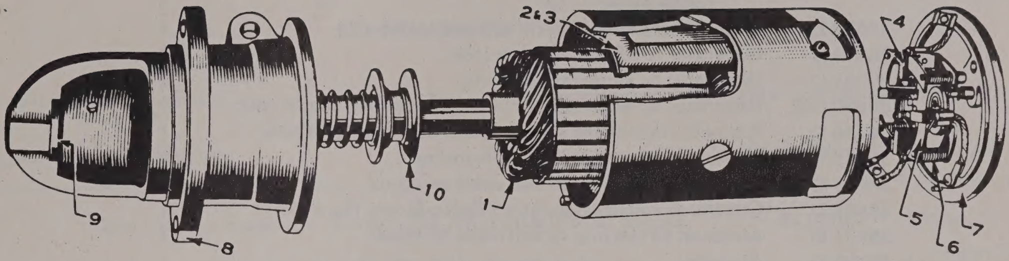
PART NO.	QUANTITY	PART NAME
631-13	1	Oil and Water Safety Control
631-2	1	Right Angle Temperature Gage
631-8A-4A	1	Flexible Exhaust Hose
631-8A-5	1	Exhaust Silencer
631-5A-3	1	Flexible Coupling
631-5A-14	1	Pilot Bearing
631-2-X	1	Steel Base
631-5A-7	2	Batteries
631-11	1	Battery to Ground Cable
631-11	1	Battery to Starter Cable
631-11	1	Battery to Battery Cable
631-5A-28	1	Center Battery Clamp
631-5A-29	2	End Battery Clamp
631-5A-30	1	Center Battery Support
631-5A-31	2	End Battery Support
631-7A-X	1	Air Duct Adapter
631-6A	1	Coupling Guard
631-20A-X	1	Pump Drive Guard
631-18A-X	1	Fan Guard (Right Side)
631-19A-X	1	Fan Guard (Left Side)
631-5A-26	1	Engine Groove Pin, ⅜″ x 3½″
631-5A-27	1	Engine Groove Pin, ⅜″ x 3″
631-5A-39	2	Alternator Groove Pin, ½″ x 3½″
631-5A	1	Condenser-Radio Interference Suppressor
631-22A-6	2	Rubber Lamp Sockets
631-22A-9	1	Toggle Switch
631-22A-14	1	Greenfield Conduit
631A-23-X	1	Control Cabinet Base
631-14A	1	Name Plate—Power Unit
631-530	1	Fulton-Sylphon Safety Control



PARTS LIST

MODEL 1101737 BATTERY CHARGING GENERATOR

ILLUS. REF.	PART NUMBER	NO. REQ.	PART NAME
1	1878273		Armature
2	1872244		Field Coil—Right Hand
3	1872243		“ “ —Left Hand
4	809637		Main Brush
5	809637		Third Brush
6	809642		Arm or Holder for Brush
7	809658		Main Brush Spring
8	809644		Third Brush Spring
9	809698		Brush Plate
10	817216		Frame—Commutator End
11	812823		Bearing— “ “
12	1874338		Frame—Drive End
13	3203 1HC-1266-C		Bearing— “ “



PARTS LIST

MODEL 1109106 STARTING MOTOR

Illus. Ref.	Part Number	No. Req.	Part Name
1	1843657		Armature
2	33347		Field Coil—Right-Hand or upper
3	38345		“ “ —Left-Hand or upper
4	38367		Brush
5	34846		Brush Spring
6			
7	1843655		Frame—Commutator End
8	1881584		Housing—Motor Drive
9	826462		Bushing—Motor Drive Housing
10	1881585		Motor Drive—Bendix

PARTS LIST

ELECTRIC STARTING EQUIPMENT

Part No.	Description	No. Used
5992 D	Generator bracket	1
....	Cap screw, 7/16″ N.C. x 1¼″	2
....	Lockwasher, 7/16″	2
27618 D	Generator to ammeter cable loom clamp ring	1
28322 D	Generator to ammeter cable loom	1
29325 D	Generator to ammeter cable clip	2
30699 DX	Generator to ammeter cable with loom and clamp ring	1
30746 D	Ammeter to starting switch cable, with two terminals	1
38433 D	Generator to ammeter cable terminal	2
38433 D	Ammeter to starting switch cable terminal	1
38601 D	Generator voltage regulator (Delco-Remy No. 5838)	1
38937 D	Ammeter to starting switch cable terminal	1
42383 D	Ammeter	1
43006 D	Generator heat shield assembly	1
58017 D	Starting motor (Delco-Remy No. 1109106)	1
....	Cap screw, ⅜″ N.C. x 1″	3
....	Lockwasher, ⅜″	3
58018 D	Starting switch to starting motor cable	1
59239 D	Starting switch spacer	2
61216 D	Battery to battery cable	1
68184 DM	Battery to starting switch cable, with negative and lug terminals	1
68185 DM	Battery to ground cable, with positive and lug terminals	1
61298 D	Generator (Delco-Remy No. 1101737)	1
....	Cap screw, 5/16″ N.F. x 1⅜″	1
....	Hex. nut, 5/16″ N.F.	1
....	Lockwasher, 5/16″	1
61241 D	Rubber insulating tubing (battery to battery cable)	1
26375 H	Battery to battery cable positive terminal	1
26375 H	Battery to ground cable positive terminal	1
26376 H	Battery to battery cable negative terminal	1
26376 H	Battery to starting switch cable negative terminal	1
26452 H	Battery to battery cable negative terminal	1
26453 HX	Battery to starting switch cable terminal bolt, with nut	1
26453 HX	Battery to battery cable positive terminal bolt, with nut	1
26453 HX	Battery to battery cable negative terminal bolt, with nut	1
26453 HX	Battery to ground cable terminal bolt, with nut	1
46074 H	Starting switch to starting motor cable terminal	2
46074 H	Battery to starting switch cable lug terminal	1
46074 H	Battery to ground cable lug terminal	1
64931 H	Starting switch (Delco-Remy No. 405-C)	1
....	Round head slotted machine screw, ¼″ N.C. x 1¾″	2
....	Hex. nut, ¼″ N.C.	2
....	Lockwasher, ¼″	2

INTERNATIONAL DIESEL ELECTRIC COMPANY, INC.

36-50 — 38th Street, Long Island City, N. Y.

U. S. Army Signal Corps Contract W-2124-sc-3637—Order No. 1628-PHILA-43

S.C. Serial No.________________ Generator No.________________

Intl. Harvester Serial No.________________ Partial Shipment No.________________

CONSOLIDATED PACKING LIST

No. Boxes 2	Marked	Description	Gross Weight	Cu. Content
	Box "1" of 2 boxes	Power unit PE-215-A Diesel engine driven, with control unit, and Spare parts for Power unit PE-215-A	8925 lbs.	306 cu. ft. 144″x68″x54″
	Box "2" of 2 boxes	Battery Acid for Power Unit PE-215-A	59 lbs.	2 cu. ft. 23″x8″x18″

DESTINATION

MARKINGS

Case 1
Page 2

INTERNATIONAL DIESEL ELECTRIC COMPANY, INC.

36-50 — 38th Street, Long Island City, N. Y.

POWER UNIT PE-215-A, DIESEL ENGINE DRIVEN

U. S. Army Signal Corps Contract W-2124-sc-3637—Order No. 1628-PHILA-43

S.C. Serial No.____________ Generator No.____________

Intl. Harvester Serial No.____________ ____________

PACKING LIST

Check Insp.	Ship	Qty.	Item	Size	Name	Number
		1	Generating Unit Complete			
			with 6 cyl. Diesel Engine		Int'l. Harvester	UD-18
			3 phase alternator and	50 KW, 240 volt	General Electric	ATI
			exciter	1.5 KW	" "	BC-78-D
		1	Y exhaust assembly		Int'l. Harvester	631-8A
		1	Hand Crank			
		1	Air Cleaner			
		2	Storage batteries, dry chgd.	6 volts	U S L	TSR4-190
		1	Battery connector			
		1	Flexible metal exh. hose	3″ I.D. x 36″ lg. 3″ std. nipple welded each end	631-8A	RW-89
		1	Exhaust muffler	3″	Burgess	STC-3
		1	Length copper tubing with flared male pipe union fitting each end—fuel intake	3/8″ I.D. x 20 ft. lg.	Int'l. Dies. Elec.	631165
		1	Length copper tubing with flared male pipe union fitting each end—fuel overflow	1/2″ I.D. x 20 ft. lg.	Int'l. Dies. Elec.	631164
		1	Reducing bushing—blk.	1/2″ x 3/8″		
		2	Length exhaust pipe—blk.	3″ x 10 ft. lg.	T.B.E.	
		4	Pipe couplings—blk.	3″		
		2	90° elbows—blk.	3		
		1	Tool box with tools	See Page #3		

INTERNATIONAL DIESEL ELECTRIC COMPANY, INC.
36-50 — 38th Street, Long Island City, N. Y.

POWER UNIT PE-215-A, DIESEL ENGINE DRIVEN

U. S. Army Signal Corps Contract W-2124-sc-3637—Order No. 1628-PHILA-43

S.C. Serial No.________________ Generator No.________________

Intl. Harvester Serial No.________________ ________________

PACKING LIST

Check Insp.	Check Ship	Qty.	Item	Size	Name	Number
		1	Air Circuit breaker	175 amp.	General Electric	AEIA
		1	Voltage regulator	240 volt	" "	3GA37CI
		1	Ammeter	0-200-A	" "	8AW-40
		1	Voltmeter	0-300-V	" "	8AW-40
		1	Current transformer		" "	
		1	Potential transformer	240/120V	" "	
		4	Synchronizing lamps	25W, 230V		
		1	Synchronizing switch	6 A	Cutler-Hammer	
		1	Exciter field rheostat		Ward-Leonard	
		1	Set electrical connections between generator and control unit in flexible conduit.			
		1	Bottle Oil for circuit breaker . .			
		2	Owner's Manuals		Int'l. Harvester	
		2	Parts Lists		" "	
		2	Wiring Diagrams		Int'l. Dies. Elec.	Q-631A-21
		2	Wiring Diagrams for making connections in field		" " "	Q-631-26
		2	Instruction Manuals		General Electric	GEH-1244

CHECKED BY:________________ INSPECTOR:________________

Case 1
Page 3

INTERNATIONAL DIESEL ELECTRIC COMPANY, INC.

36-50 — 38th Street, Long Island City, N. Y.

TOOLS FOR POWER UNIT PE-215-A

U. S. Army Signal Corps Contract W-2124-sc-3637—Order No. 1628-PHILA-43

S.C. Serial No.________________ Generator No.________________

Intl. Harvester Serial No.________________ ________________

PACKING LIST

Check				International Harvester No.
Insp.	Ship	Qty.	Item	
		1	Control unit complete with following mounted in place:	
		1	Water pump wrench	11858 DA
		1	Hex. socket wrench 9/16″	19289 D
		1	Hex. socket wrench ⅝″	19291 D
		1	Hex. socket wrench ¾″	19292 D
		1	Hex. socket wrench ⅞″	19324 D
		1	Hex. socket wrench 13/16″	19325 D
		1	Hex. socket wrench 1″	19326 D
		1	Hex. socket wrench 1⅛″	19327 D
		1	Hex. socket wrench Carrying Case	19328 D
		1	Comb. socket wrench handle	19323 D
		1	Square socket wrench ½″	20156 D
		1	Square socket wrench 11/16″	20157 D
		1	Stem handled socket wrench 1-1/32″	25462 DA
		1	Stem handled socket wrench handle	25463 D
		1	Spark plug wrench 31/32″	32941 D
		1	Spark plug wrench handle	25466 D
		1	Adjustable steel wrench 12″	8E
		1	Oil can	H 156
		1	Lubricator 9 oz.	Q 3794
		1	Screw driver 6″	2588 T
		1	Pliers 8″	2587 T
		2	Exciter Shims	General Electric

CHECKED BY:________________ INSPECTOR:________________

INTERNATIONAL DIESEL ELECTRIC COMPANY, INC.

36-50 — 38th Street, Long Island City, N. Y.

ENGINE SPARE PARTS FOR POWER UNIT PE-215-A

U. S. Army Signal Corps Contract W-2124-sc-3637—Order No. 1628-PHILA-43

PACKING LIST

CHECK				FACILITY	
INSP.	SHIP	QTY.	ITEM	NAME	NUMBER
		2	Fuel Supply pump belts	Int'l. Harvester	49341 D
		4	Fan Belts	" "	42937 DX
		1	Set Engine Gaskets	" "	52726 D
		1	Lubricating felt, Valve mech.	" "	32462 D
		2	Oil seal felts, crankshaft	" "	32307 DA
		2	Felt washers, gear cover	" "	36798 D
		1	Oil seal retainer, gear cover	" "	36799 D
		1	Oil seal retainer, crankshaft	" "	39401 D
		1	Felt washer, water pump	" "	20300 D
		1	Oil seal, water pump	" "	20290 D
		1	Oil seal, water pump	" "	20289 D
		1	Felt washer, fan idler pulley	" "	32514 DA
		1	Oil seal, starting valve mech.	" "	42760 D
		1	Oil seal, starting valve mech.	" "	32460 D
		6	Nozzle Body Dust Seal	" "	61208 D
		6	Nozzle Body retainer dust seal	" "	61209 D
		6	Gaskets, nozzle	" "	43002 D
		6	Gaskets, nozzle	" "	42767 D
		1	Oil seal, fuel pump drive shaft	" "	12480 L
		1	Felt	" "	32362 D
		1	Oil seal, fuel pump drive shaft	" "	33788 D
		1	Fuel filter element—metal	" "	28809 D
		3	Fuel filter elements—cloth	" "	29501 DA

ENGINE SPARE PARTS FOR POWER UNIT PE-215-A (Continued)

U. S. Army. Signal Corps Contract W-2124-sc-3637—Order No. 1628-PHILA-43

PACKING LIST

Check				Facility	
Insp.	Ship	Qty.	Item	Name	Number
		160	Lub. oil filter elements	Int'l Harvester	50308 D
		6	Injection nozzles, complete	“ “	52613 D
		12	Water pump packings	“ “	50790 D
		1	Main bearing—front	“ “	47756 DX
		4	Main bearings—Inter.	“ “	47757 DX
		1	Main bearing—center	“ “	47758 DAX
		1	Main bearing—rear	“ “	47759 DX
		6	Cylinder sleeves and pistons with pins and rings	“ “	42696 D
		1	Connecting rod	“ “	42687 DAX
		12	Connecting rod bearings	“ “	42688 DAX
		6	Exhaust valves	“ “	32482 DB
		6	Intake valves	“ “	42747 D
		12	Valve Springs	“ “	32483 D
		12	Valve guides	“ “	5025 DBR
		2	Radiator outlet hose	“ “	42614 D
		1	Radiator inlet hose	“ “	42612 D
		1	Thermostat hose	“ “	42656 D
		1	Lubricating oil pump	“ “	43990 D
		3	Brushes, chg. gen.	Delco-Remy	809637
		6	Brushes, stg. motor	“ “	38367

CHECKED BY:________________ INSPECTOR:________________

INTERNATIONAL DIESEL ELECTRIC COMPANY, INC.

36-50 — 38th Street, Long Island City, N. Y.

MISCELLANEOUS SPARE PARTS FOR POWER UNIT PE-215-A

U. S. Army Signal Corps Contract W-2124-sc-3637—Order No. 1628-PHILA-43

PACKING LIST

CHECK				FACILITY	
INSP.	SHIP	QTY.	ITEM	NAME	NUMBER
		1	Brush plate, insulated	Delco-Remy	809698
		1	Pin and insulation-brush holder hinge—chg. gen.	“ “	812016
		1	Pin and insulation-brush holder stop—chg. gen.	“ “	812015
		12	Insulating washers, starting motor 9/16″	I.D.E. Co.	114944
		12	Insulating washers, starting motor 9/32″	I.D.E. Co.	365038
		6	R. H. Iron Rivets for starting motor insulation washers		
		8	Brushes, alternator	Gen. Elec.	K 5804490
		1	Alternator Brush Holder	“ “	M 5844427AB-G1
		1	Bearing, alternator (SKF-6315)	“ “	C 20C315A
		1	Brush holder, stud and insulation	“ “	K 5823467ADG1
		2	Bearings, exciter	“ “	4213223
		1	Brush holder assembly with 4 brushes	“ “	K 8104781AB
		4	Brushes, exciter	“ “	K 8104785AA2
		2	Exciter V-Belts	Gates	51-A
		20	Studs for coupling	Ajax	7
		20	⅝″ SAE Nuts	Ajax	
		20	⅝″ Lockwashers	Ajax	
		20	Bushings for coupling	Ajax	
		2	Bottles cement	Ajax	
		1	Wrench, socket and handle for Ajax coupling		

CHECKED BY:____________________ INSPECTOR:____________________

INTERNATIONAL DIESEL ELECTRIC COMPANY, INC.

36-50 — 38th Street, Long Island City, N. Y.

TOOLS FOR POWER UNIT PE-215-A

U. S. Army Signal Corps Contract W-2124-sc-3637—Order No. 1628-PHILA-43

S.C. Serial No.__________ Generator No.__________

Intl. Harvester Serial No.__________

PACKING LIST

Check			
Insp.	Ship	Qty.	Item
		1	Container of Electrolyte for 2 batteries

CHECKED BY:__________ INSPECTOR:__________

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